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PREPARED

BY

OFFICE OF SPACE SCIENCES

This document has been prepared by the discipline-oriented Subcommittees of the Space Sciences Steering Committee. It contains the approved NASA program in space sciences as of 1 September 1963.

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INTRODUCTION

This document has been prepared by the discipline-oriented Subcommittees of the Space Sciences Steering Committee. It contains the approved NASA program in space sciences as of 1 September 1963. (This document supersedes the 1 December 1962 edition.)

The document has been prepared to serve primarily as an aid in budget preparation and as a basis for future program planning.

Funds for data analysis will be provided to each space flight experimenter after his spacecraft has been placed into a suitable trajectory and satisfactory data are being received from his experiment for analysis.

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Within each discipline section are summaries of the approved experiments and supporting research which are detailed in the following reference sheets.

Within the tables are capsule descriptions of the experiments and supporting research, the names of the several experimenters and investigators, and their corresponding affiliations. For each experiment and supporting research listing there is an indication of the discipline having prime responsibility or merely having interest, as noted by X and ✓, respectively.

The discipline areas are as follows:

	I
	S P R P
	A P A P F P B
Astronomy	
Solar Physics	
Planetary Atmospheres	
Ionospheres and Radio Physics	
Particles and Fields	
Planetology	
Bioscience	

Following the discipline sections are reference sheets which give detailed information on the approved experiments and supporting research being done under contracts or grants and within the NASA Centers. They are arranged as follows:

Satellites and space probes, by projects;

Sounding rockets and other flight experiments,
in numerical order by launch vehicle; and

Supporting research, in alphabetical order by
states and by NASA Centers.

The project designations have been revised so that now each project carries a designation within one of the approved generic series defined below. Before launch a chronology of conception is maintained by a letter suffix, e.g. A, B, C; after launch a chronology of success is maintained by the assignment of a Roman numeral suffix replacing the before-launch letter suffix. Success is defined as one or more orbits of a satellite and for a probe as the achievement either of planned flight or a flight of 90 minutes or more duration.

Generic Series

Types of Missions

Explorer	An earth satellite of relatively simple design used to investigate areas of space science.
Observatory (with adjective modifier e.g. Astronomical)	An earth satellite usually of relatively large size and containing a system for stabilization along more than one axis. The observatory is used to carry out extensive measurements of an intra- or interdisciplinary nature, e.g. solar physics, astronomy, etc.
International Satellites	Satellites which call for international cooperation with either national units of scientists or with individual scientists.
Relay	The active repeater communications satellite which is being used for experiments at the medium altitude.
Ranger	One of a series of unmanned lunar spacecraft designed to obtain exploratory data on the lunar environment.
Surveyor	One of a series of unmanned lunar landing or orbiting spacecraft designed to obtain definitive data on the lunar environment.
Mariner	One of a series of simple planetary spacecraft leading to flight in the vicinity of a planet and capable of making a flyby or of releasing a landing capsule.
Pioneer	A relatively simple deep space probe or interplanetary space craft.

The old and new project designations are listed for the reference sheets which are assembled in the following order.

SATELLITES

<u>New Designation</u>	<u>Old Designation</u>
Air Density/INJUN Explorers	Air Density/INJUN Explorers
AD-A	none
AD/I-B	none
AD/I-C	none
Energetic Particles Explorers	Energetic Particles Satellite
EPE-D	S-3c
Atmosphere Explorers	Atmospheric Structure Satellite
AE-B	S-6a
Ionosphere Explorers	Fixed Frequency Topside Sounder
IE-A	S-48
IE-B	S-48a
Beacon Explorers	Polar Ionosphere Beacon
BE-A	S-66
BE-B	S-66a
Interplanetary Explorers	Interplanetary Monitoring Platforms
IMP-A	S-74
IMP-B	S-74a
IMP-C	S-74b
Orbiting Solar Observatory	Orbiting Solar Observatory
OSO-B	S-17
OSO-C	S-57
OSO-D	none
OSO-E	none

SATELLITES (Contd.)

<u>New Designation</u>	<u>Old Designation</u>
Orbiting Astronomical Observatory	Orbiting Astronomical Observatory
OAO-A	S-18
OAO-B	S-58
OAO-C	S-68
Orbiting Geophysical Observatory	Orbiting Geophysical Observatory
OGO-A	S-49
OGO-B	S-49a
OGO-C	S-50
OGO-D	S-50a
<u>International Satellites</u>	
United Kingdom Satellites	United Kingdom #1, #2, & #3
UK-C	S-52
UK-D	S-52a
San Marco	Italian Satellites
SM-A	none
SM-B	none
Relay	Communication Satellites
Relay-B	A-17
Relay-C	A-19

SPACE PROBES

<u>New Designation</u>	<u>Old Designation</u>
Ranger	Ranger - Block III
Ranger-A	Ranger-6
Ranger-B	Ranger-7
Ranger-C	Ranger-8
Ranger-D	Ranger-9
Surveyor	Surveyor - Block I
Surveyor-E	Surveyor-5
Surveyor-F	Surveyor-6
Surveyor-G	Surveyor-7
Surveyor-H	Surveyor-8
Mariner	Mariner
Mariner-C	Mariner C-64
Mariner-D	Mariner C-64
Pioneer	Pioneer
Pioneer-A	Pioneer-1
Pioneer-B	Pioneer-2

Experimenters, Investigators,
Affiliations, and Abbreviations

NASA

Ames Research Center, (AmesRC), California
Flight Research Center, California
Goddard Space Flight Center, (GSFC), Maryland
Jet Propulsion Laboratory, (JPL), California
Langley Research Center, (Langley), Virginia
Lewis Research Center, (Lewis), Ohio
Marshall Space Flight Center, (MSFC), Alabama
NASA Headquarters, (NASA Hqs), District of Columbia

US Government

Air Force Cambridge Research Laboratory, (AFCRL), Massachusetts
Argonne National Laboratory, Illinois
National Bureau of Standards (NBS)
 Central Radio Propagation Laboratory (CRPL), Colorado
 Washington, D. C. (DC)
Peru
Naval Research Laboratory, (NRL), District of Columbia
Smithsonian Astrophysical Observatory, (SAO), Massachusetts
USAF Aerospace Medical Laboratory, Texas
U. S. Army Ordnance Land Locomotion Laboratory, Michigan
U. S. Atomic Energy Commission, (AEC), Oak Ridge National
 Laboratory, Tennessee
U. S. Geological Survey, (USGS), Arizona
U. S. Naval School of Aviation Medicine, Florida

Foreign

Cambridge University, England
Canterbury, University of, New Zealand
Dominion Observatory, Canada
Imperial College, London
Indian National Committee for Space Research
Italian Space Commission
Leicester University, England
Manchester, University of, England
Manila Observatory, Philippines

Foreign (Contd.)

Max-Planck Institute, Germany
Meteorological Office, UK Air Ministry
National Center for Space Studies/National Center for
Telecommunications Studies, (CNES/CNET), France
Paris, University of, France
Radio Research Laboratory, Japan
University College, London
University of Western Ontario, Canada

Universities and Non-profit Organizations

Alaska, University of
Arizona State University
Arizona, University of
Armour Research Foundation, Illinois
Association for Advanced Mental Health, Indiana
Boston University, Massachusetts
Brandeis University, Massachusetts
Brigham Young University, Utah
California, University of,
 Berkeley (UC Berkeley)
 La Jolla (UC La Jolla)
 Lawrence Radiation Laboratory (UCLRL)
 Livermore
 Los Angeles (UCLA)
 San Diego (UCSD)
 Santa Barbara
California Institute of Technology, (CIT)
Catholic University, Washington, D. C.
Chicago, University of, Illinois
Cincinnati, University of
City of Hope Medical Center, California
Colorado, University of (U. of Colo.)
Columbia University (Lamont Geophysical Laboratory) New York
Communications Research Institute, Florida
Cornell University, New York
Dartmouth College, New Hampshire
Detroit, University of, Michigan
Dudley Observatory, New York
Fels Research Institute, Ohio
Florida State University

Universities and Non-profit Organizations (Contd.)

Fordham University, New York
Franklin Institute, Bartol Research Foundation, Pennsylvania
Geophysical Institute of Alaska
George Washington University, Washington, D. C.
Georgetown University Observatory, Washington, D. C.
Georgia Institute of Technology
Graduate Research Center of the Southwest, (GRCSW), Texas
Harvard College Observatory, Massachusetts
Harvard University, Massachusetts
Hawaii, University of
Hollins College, Virginia
Houston, University of, Texas
Illinois, University of
Indiana University
Iowa, State University of, (SUI)
Johns Hopkins University, (JHU), Maryland
Kansas, University of
Kentucky, University of
Kitt Peak National Observatory, Arizona
Lowell Observatory, Arizona
Maryland, University of
Massachusetts Institute of Technology, (MIT)
Medical Science Research Foundation, San Francisco, California
Mellon Institute, Pennsylvania
Michigan, University of
Minnesota, University of
Mississippi State University
New Hampshire, University of
Nevada, University of
New Mexico, University of
New Mexico State University
New York University (NYU)
North Carolina, University of
Northeastern University, Massachusetts
Ohio State University
Oklahoma State University
Pasadena Foundation for Medical Research, California
Pennsylvania State University
Pennsylvania, University of
Pittsburgh, University of, Pennsylvania
Princeton University, New Jersey
Purdue Research Foundation, Indiana

Universities and Non-profit Organizations (Contd.)

RAND Corporation, California
Rensselaer Polytechnic Institute, (RPI), New York
Rice University (Rice), Texas
Rochester, University of, New York
Southern California, University of
Stanford Research Institute, (SRI), California
Stanford University, California
St. Louis University, Missouri
Temple University, Pennsylvania
Texas A & M
Texas, University of
Texas Woman's University
University Corporation for Atmospheric Research, (UCAR),
Colorado
Vanderbilt University, Tennessee
Washington University, Missouri
Western State College of Colorado
Wisconsin, University of
Yale University, Connecticut
Yerkes Observatory, Wisconsin

Industry

Airborne Instruments Laboratory, (AIL) Cutler-Hammer, Inc.
New York
American Science & Engineering, Inc. Massachusetts
Astronautics Corp. of America, Wisconsin
Ballistics Research Laboratory, (BRL), Michigan
Bell Telephone Laboratories, Inc., New York
E. I. DuPont de Nemours & Co., Delaware
Dikewood Corp., New Mexico
Esso Research & Engineering, New Jersey
Geophysics Corporation of America, (GCA), New York
Grumman Aircraft Engineering Corp., New York
Institute for Defense Analysis, Washington, D. C.
International Telephone and Telegraph Corporation, (IT&T)
New Jersey
Lockheed Missile and Space Division, (Lockheed), California
Melpar Inc., Virginia
Resources Research Inc., District of Columbia
Schwarz Bio-research Inc., New York
Space Technology Laboratories, (STL), California
United Aircraft Corporation Systems, Connecticut

ASTRONOMY

OBJECTIVES:

The Astronomy Program is designed to extend the traditional observational techniques of astronomers to the study of celestial objects from positions above the earth's atmosphere and therefore under conditions free from the absorption or scattering effects of that atmosphere. At the present time, this program is primarily concerned with the observation of the many wavelengths emitted by astronomical objects to which the earth's atmosphere is opaque. Observations which exploit the freedom from the effects of the earth's atmosphere are also being considered, but due to the lack of suitable instrumental techniques such observations now play only a minor role in the Astronomy Program. Depending on the wavelength, astronomical observations must be made from altitudes ranging from a minimum of 100,000 feet for the visible and infrared wavelengths to altitudes of at least several thousand kilometers for observations in the long-wave radio wavelengths.

PLANETARY, STELLAR, AND GALACTIC ASTRONOMY

Ultraviolet and infrared astronomy make use of optical systems only slightly modified from those used in the normal visible window and hence require the least change in the techniques used by earth-based astronomers. Many stars and all planets and emission nebulae emit a large fraction of their energy in wavelengths which can not be observed readily from the earth's surface. Thus, astronomers have been forced to make extensive extrapolations to estimate both the total energy emitted by astronomical bodies and that portion absorbed by interstellar material. In many cases they have been forced to hypothesize conditions in stellar and planetary atmospheres without any means of checking these hypotheses. For example, it is commonly assumed that most of the Martian atmosphere is composed of molecular nitrogen. However, molecular nitrogen neither absorbs nor emits in any wavelength region which can be observed from the earth and hence its

presence can be "established" only by the small likelihood of another type of molecule contributing to the Martian atmospheric pressure. Similarly, we assume that, except for relatively small and now well recognized variations, the cosmic abundances of elements is constant throughout the universe. Yet, nearly one-third of the elements found on the earth have not been observed in any astronomical object because of the impossibility of making earth-based observations of their emission or absorption lines.

Dust between the stars reddens the light reaching the earth. This phenomenon is the result of the greater penetration of red wavelength light through the dust particles accompanied by the greater absorption and scattering of blue wavelength light by the dust. Dust grains also polarize the light we receive from the stars. Although interstellar dust comprises a major fraction of the mass in the universe, astronomers are not yet agreed as to its exact nature since many types of material could give rise to the optical effects observed between 3,000Å and 10,000Å. Observations in the ultraviolet region will be particularly important in establishing the nature of the interstellar particles while observations in the infrared region will lead to an improvement in our estimates of total interstellar absorption.

In recent years astronomers have made numerous observations of the intensity of the brightest stars in the wavelengths between 1,000Å and 3,000Å. These observations have already indicated that our understanding of stellar atmospheres is sufficiently poor that one can not explain why stars emit as little radiation as they do in this spectral region. Equally puzzling is the fact that stars which look nearly identical in wavelengths penetrating to the ground seem to differ greatly from one another in ultraviolet wavelengths. Neither of these effects is understood at present and more data must be obtained in order to understand the problem. Photometric and broadband spectrophotometric observations also contain data which will help to extend the stellar reddening law to the ultraviolet. However, it will be difficult to interpret such data until we have a better understanding of the behavior of the stars themselves.

The major questions on which this portion of the Astronomy Program is now concentrated are:

1. What is the total radiation emitted by stars of each spectral type and how is this radiation distributed in wavelengths?
2. Why do otherwise apparently similar stars differ so greatly in the ultraviolet?
3. What is the composition and structure of interstellar dust and gas?
4. What are the major molecular constituents in planetary atmospheres and in interstellar gas?
5. What is the spectral distribution of the energy emitted by emission nebulae and what are the details of the energy balance problem for these objects?

Finally, it is less exciting but equally important to the long range program to provide maps of the sky in several ultraviolet and infrared wavelengths. These maps must indicate not only the position of various objects but their approximate brightness as well.

The first three Orbiting Astronomical Observatories (OAO) are being designed to provide much of the data which will be needed in the ultraviolet region of the spectrum to answer these fundamental questions. Consideration is being given to using the fourth OAO to obtain such information in the infrared. In addition, sounding rocket and X-15 airplane flights will continue to be used for studies of the sky, particularly in the ultraviolet.

Gamma ray, X-ray, and radio astronomy deal with regions of the spectrum in which the black body radiation of most astronomical objects is weak. Emissions in these wavelengths arise in the very hot corona surrounding the sun and presumably in similar coronae surrounding other stars, and in regions of space where electrons and ions have velocities far in excess

of those derivable from thermal energy. Normally, and possibly exclusively, these high particle velocities are associated with relatively strong magnetic fields which may provide a mechanism for accelerating particles to these energies. The existence of such regions is well established by radio astronomy observations, by the existence of galactic cosmic rays, and by x-ray observations of the sun. However, most of the emission from objects of this type occurs in wavelengths which can not be observed from the surface of the earth. Largely because of this, we have very little understanding of the physical characteristics of these regions, which contribute significantly to the total energy content of the galaxy.

The EXPLORER XI satellite provided the first direct observations in this area. The results indicated that the amount of gamma ray emission from the galaxy is approximately that which had been predicted with conservative theories. The data were sufficient to rule out the theory of continuous creation of the universe in which matter and anti-matter are created in essentially equal quantities throughout space. Additional gamma ray telescopes are being flown on the Orbiting Solar Observatories (OSO) to repeat and extend the EXPLORER XI observations. Several x-ray telescopes have been flown in sounding rockets. These flights have proven that x-ray "stars" do exist but that they are not a type of object which we can yet recognize from studies in other spectral regions. Those objects which we have thought might be bright in the x-ray region are, at least, not the brightest x-ray "stars" to be found. Continuing rocket flights together with experiments being carried on the OSO and OAO satellites will provide the additional data we need to identify and obtain a minimum understanding of these objects. The brightness in the long wave radio region of the galactic halo and of most radio sources increases with increasing wavelength throughout the region in which the earth's ionosphere begins to prevent earth-based observations. For various reasons, resulting both from the physical characteristics of the sources and from the characteristics of the intervening interstellar and interplanetary media, the intensity can not continue to increase indefinitely. Data collected from a Journeyman rocket flight indicate

that a maximum of intensity may occur near a wavelength of 300 meters, but this is not definitely established. Receivers to be flown on additional sounding rocket flights and the Orbiting Geophysical Observatories (OGO) will, hopefully, establish the average wavelength of the maximum intensity. Observations with more directive antennae will be needed to study the characteristics of individual sources.

Following are the major problems in this portion of the Astronomy Program on which the current flight program is concentrating:

1. What is the average intensity of the galactic gamma ray background and can this be understandably reconciled with the observed galactic cosmic ray background?
2. Are gamma rays produced fairly uniformly throughout the galaxy or are they concentrated in a relatively small number of discrete gamma ray "stars"?
3. What is the nature of x-ray "stars"?
4. What is the long wavelength spectrum of galactic radio emission?

Visible and Short Wave Radio Region

Observations in this portion of the spectrum will be useful for the study of planets, of emission nebulae, of close double stars, the possible detection of planetary companions to nearby stars, and studies of crowded star fields such as those found in clusters and distant galaxies. For this reason the Supporting Research and Technology (SRT) program includes the development of very high resolution photographic and television systems to be flown in the Stratoscope II balloon program and the development of the other components and systems which will be needed to exploit these wavelength regions.

GRAVITATIONAL ASTRONOMY

The development of satellites and space probes has provided a great impetus to the revitalization of the pursuit of gravitational astronomy. Both the planning for and the deduction of satellite and space probe trajectories have led to the development of new techniques in gravitational astronomy, which in turn have stimulated the application of these techniques to our understanding of the motions of the astronomical bodies. Satellites have also proven exceedingly useful for mapping the gravitational field of the earth and they are becoming increasingly useful for establishing the relative positions of geographical locations on the earth. Although many satellites have been used for such studies, starting with VANGUARD I, ANNA IB was the first satellite especially designed to study geodesy. Additional satellites in different inclinations and altitudes are necessary for the complete mapping of the earth, both geographically and gravitationally. The use of satellites also extends the size and environmental conditions of the "laboratories" in which we may conduct experiments on the nature of gravity.

Supporting Research and Technology funds are being used to develop equipment which is expected to provide data for increases in our understanding of the fundamental nature of gravity.

Within the present flight program the primary studies related to the geodesy of the earth are:

1. Can we produce a complete mathematical description of the gravitational field of the earth? If so, what is the expression for this field?
2. Can geodesists interconnect geodetic networks of various continents and various geographical areas, each of which is presumably adequate by itself?
3. Can we locate positions of islands and other isolated geographical regions in the same coordinate system as that in which the major continents are located?

TECHNIQUES AND INSTRUMENTS:AVAILABLE:Planetary, Stellar and Galactic Astronomy

The optical systems and photomultiplier detectors which are used commonly in the photographic region can be applied, with minor modifications, to the ultraviolet region. These modifications include new surface coatings which increase the reflectivity of optics, changes in sensitivity of cathodes in the ultraviolet spectral region, and the development of new filters to isolate particular wavelength bands. An electronic readout image tube has also been developed for the ultraviolet region of the spectrum.

Optically short antennae, in lengths up to 100 feet, are available for observations in the long wavelength radio region. Receiver techniques for space use involve fairly straightforward packaging of circuitry developed for terrestrial radio reception.

The fundamental detector for the gamma ray region is a Geiger counter surrounded by a plastic shield. The latter counts only charged particles entering the Geiger counter and eliminates these from the accumulated statistics. Only the most crude collimating systems are available in this spectral region. Both scintillating plastics and ionization chambers are used to study the X-ray region. Parabolic collimators are being developed to focus the light falling on a much larger area onto the small detector. Grating instruments and crystal spectrometers are also available, but their low sensitivity in comparison with the low intensities available in astronomical sources has prevented the application of these to sources other than the sun.

Gravitational Astronomy

The spacecraft instrumentation to study the gravitational astronomy problems consists primarily of some type of beacon which can be adequately and accurately tracked. Such beacons include a high energy gas discharge light which can

be flashed periodically, a transmitter driven by a very stable oscillator, and a transponder system. The flashing light provides an image whose position can be accurately photographed against a star background - a very accurate inertial reference frame. The radio transmissions are compared with the output of an equally stable transmitter on the ground to permit the accurate measurement of the satellite's velocity. The transponder replies after a known time lapse to permit accurate measurement of the total transmission path length between the ground observer and the satellite. In addition, many successful geodetic measurements have been accomplished by observing sunlight reflected from satellites. In these cases, cameras with accurately-timed shutters are used on the ground to provide breaks in the registration of the path of the satellite which may be measured and compared accurately with the positions of the stars recorded on the same photographic plate.

UNDER DEVELOPMENT

Imaging collimators for the x-ray region of the spectrum and improved cathodes, reflecting surfaces, and filters for the ultraviolet region are being developed. Emphasis is being placed on higher resolution, more sensitive image tubes for the ultraviolet and the visible regions of the spectrum. The problems of adapting to space-astronomy use infrared detectors which have been developed for non-astronomical uses are being investigated. Radio receiver techniques are being developed for the submillimeter wavelength region to bridge the gap between infrared techniques and those wavelengths which can be observed readily from the ground. For the long wave radio region, satellites are being designed to carry directive antennae which will permit the study of individual radio sources and individual regions of the sky. A standard source which can be used to calibrate the low frequency observations is under development.

Corner reflectors which are designed to be illuminated by bursts of laser radiation from the earth will be flown on several satellites in the near future. If successful this technique will provide a new and extremely accurate method of tracking earth satellites.

Since many areas of space astronomy can benefit from the presence of man in space, preliminary studies are under way to investigate how this may best be achieved.

S A T E L L I T E S

Project Designation and Contacts	Experimenters	Affiliations	I					
			A	P	S	P	R	P
ORBETING SOLAR OBSERVATORY (OSO-B) (Smith/Halpern)	Hallam, K.L. White, W.A.	GSFC	X					
Using a stellar spectrophotometer, examine sky for stellar and nebular sources emitting in the wavelength regions 900-2000Å and 1800-3800Å.								
Intensity and degree of polarization of zodiacal light at 4750Å and 8500Å.	Ney, E.P.	U. of Minn.	X				✓	
Arrival direction and energies of primary cosmic rays (50 Mev and up)	Leavitt, C.P.	U. of N. Mex.	✓	X				
OSO-C (Wheel Section) (Smith/Halpern)								
Gamma ray astronomy (above 100 Mev)	Kraushaar, W.L.	MIT	X				✓	
Measure spectral intensity of earth-reflected solar radiation (1000Å to 30 microns)	Neel, C.B. Robinson, G.C.	Ames R C	✓					X

S A T E L L I T E S

I

S P R P

<u>Project Designation and Contacts</u>	<u>Experimenters</u>	<u>Affiliations</u>	A	P	A	P	F	P	P	B
<u>ORBITING ASTRONOMICAL OBSERVATORY (OAO-A)</u> (Roman/Sures)										
Mapping stellar UV radiation (3,000 to 1,700Å, 2,000 to 1,050Å, 1,500 to 1,050Å)	Whipple, F. Davis, R.	SAO								X
Broadband photometric studies of stellar energy distribution (1000 to 3000Å)	Code, A.D.	U. of Wisc.								X
<u>OAO-B (Roman/Sures)</u>										
Absolute spectrophotometry measurements (1,000 to 4,000Å with 2Å resolution)	Milligan, J.	GSFC								X
<u>OAO-C (Roman/Sures)</u>										
Interstellar absorption measurements (800 to 3,000Å with 0.1Å resolution)	Spitzer, L.	Princeton U.								X
Study the X-ray emission of a wide assortment of stars, nebulae, etc., using paraboloidal reflectors, photon detectors and gas counters	Boyd, R.L.F.	Univ. College, London & Leicester U.								X

S A T E L L I T E S

S A T E L L I T E S			I				
Project Designation and Contacts	Experimenters	Affiliations	A	P	A	P	P
ORBITING GEOPHYSICAL OBSERVATORY (OGO-A&B) (Schardt/Ashworth)							
Measure the cosmic noise at two fixed frequencies in the 2 to 4 Mc/s range	Haddock, F.T.	U. of Mich.	X	✓		✓	
BACKUP EXPERIMENT Investigation of the Gegenschein							
	Wolff, C.L. Hallam, K. Wyatt, S.P.	GSFC GSFC U. of Ill.	X		✓		
OGO-C&D (Fellows/Ashworth)							
Measure the cosmic noise at two fixed frequencies in the 2 to 4 Mc/s range	Haddock, F.T.	U. of Mich.	X	✓		✓	
INTERNATIONAL SATELLITE (UK-C&D)(Fellows/Halpern)							
Galactic radio noise in frequency range, 0.75 Mc to 3.0 Mc and exploration of upper ionosphere	Smith, F.G.	Cambridge U. England	✓				X

I-12

OTHER FLIGHT EXPERIMENTS

O T H E R F L I G H T E X P E R I M E N T S			I S P R P				
Project Designation and Contacts	Experimenters	Affiliations	A	P	A	P	P
<u>BALLOON (Roman/Ehrlich)</u>							
Determine anisotropy of gamma rays from 3 to 30 Mev	Overbeck, J.	MIT	X	✓			
<u>BALLOON (Smith/Ehrlich)</u>							
Record the intensity, degree of polari- zation, and polarization angle of coronal light from a few minutes of the solar limb to about 6 solar radii.	Newkirk, G.	UCAR	✓	X			
<u>X-15 (Ott/Martin)</u>							
Record stellar UV radiation (1800 to 4200Å)	Code, A.D. Houck, T. Bless, T. McNall, J. Schroeder, D.	U. of Wisc.			X		
Measure relative brightness of sky and earth background	Code, A.D.	U. of Wisc.	X				

SOUNDING ROCKETS

I-14

Project Designation and Contacts	Experimenters	Affiliations	I					
			A	P	A	P	P	P
<u>AEROBEE</u>								
4.50, 4.51, 4.52 (Roman/Holtz)								
Observe stellar spectra of the hot star Gamma Pegasi to study its UV radiation with moderate dispersion	Rogerson, J.	Princeton U.	X					
<u>ARGO D-8</u>								
11.03 (Ott/Roman)								
Determine cosmic radio background noise at several fixed frequencies between about 0.75 and 2 Mc/s	Haddock, F.T. Walsh, D. Shulte, H.F.	U. of Mich.	X					
<u>NIKE APACHE</u>								
14.127 (Opp/Holtz)								
Measurement and comparison of radiating and non-radiating sensors for support of future space radio astronomy missions	Stone, R.G.	GSFC	X					✓

S U P P O R T I N G R E S E A R C H

Project Designation and Contacts	Investigators	Affiliations	I					
			A	S	P	R	P	B
R-9 (Ott/Roman) Research on UV spectroscopy using high temperature plasma sources	Kolb, A.C.	NRL	X					
R-18 (Moore) Support of U. of Hawaii-U. of Colorado research on zodiacal light and airglow (icw NSG-135)	Roach, F.E.	NBS, CRPL	X		✓			
R-67 (Andrus/Burke) Investigate interference to radio astronomy observations due to operation of communications satellite systems	Rice, P.	NBS, CRPL	X					
R-73 (Roman/Ott) Far UV and soft X-ray radiation physics	Madden, R.	NBS	X					
NASr-82 (Moore) Construction of a 60-inch lunar and planetary telescope	Kuiper, G.P.	U. of Ariz.	✓		✓		X	
NASr-143 (Ott/Roman) Provide engineering support of the ultra-violet photography research by Code (U. of Wisconsin)	Seinfeld, R.	Astronautics Corp. of America	X					

S U P P O R T I N G R E S E A R C H

Project Designation and Contacts	Investigators	Affiliations	I							
			A	P	A	P	P	P	P	B
NsG-29 (Moore) Research on problems of satellite and planetary motion	Brouwer, D.	Yale U.	X							
NsG-43 (Moore) Fundamental research in celestial mechanics	Herget, P.	U. of Cincinnati	X							
NsG-69 (Roman/Ott) Design and construct television system for use with telescopes above the earth's atmosphere.	Schwarzschild, M.	Princeton U.	X		✓			✓		
NsG-91 (Ott/Roman) Investigate the UV photon absorption properties of various solid materials	Walker, W.C.	U. of Calif. Santa Barbara	X							
NsG-113 (Roman/Ott) Investigate properties of the interstellar dust	Greenberg, J.	RPI	X							
NsG-135 (Moore) Study on zodiacal light selected lines in the airglow spectrum (icw R-18)	Steiger, W.R.	U. of Hawaii	X		✓					

S U P P O R T I N G R E S E A R C H

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S P R P

Project Designation and Contacts	Investigators	Affiliations	A	P	A	P	P	P	B
NsG-276 (Ott/Roman) Determine future image converter requirements for orbiting observatories, methods for meeting these requirements and experimental studies of properties of promising image tube materials	Burns, J.	U. of Chicago							X
NsG-280 (Moore) Theoretical study of periodic motion and stability in the restricted problem of three bodies	Bartlett, J.H.	U. of Ill.							X
NsG-301 (Roman/Ott) High precision spectroscopy	Andrew, K.L.	Purdue Res. Foundation							X
NsG-308 (Ott/Roman) Investigate the properties and design criteria of multilayer optical filters	Baumeister, W.	U. of Rochester							X
NsG-318 (Roman/Ott) Experimental research on X- and gamma-radiation at high altitudes, including design and use of balloon-borne instrumentation	Peterson, L.E.	U. of Calif. San Diego							X

S U P P O R T I N G R E S E A R C H

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A P A P F P B

Project Designation and Contacts	Investigators	Affiliations	A	P	A	P	F	P	B
NsG-328 (Ott/Roman) Investigate emission, conductivity, and luminescence properties of solid materials	Pong, W.	U. of Hawaii	X						
NsG-355 (Ott/Roman) Investigation of specific problems concerned with the operation of the following devices in the plasma space environment - long traveling wave antenna, the synthesis of large reflector antennae with discrete elements, and the interferometer.	Sandler, S.S.	Northeastern U.							
NsG-359 (Roman) Research on measurement of atomic transition probabilities of high temperature gases	Wilkerson, T.D.	U. of Md.	X						
NsG-386 (Opp) Development of advanced plasma detectors and the preparation of plasma experiments for NASA satellite program and interpretation of the results from these experiments	Bridge, H.	MIT					X		
NsG-414 (Roman) Theoretical and/or experimental studies of UV phenomena of astronomical interest, and of galactic gas dynamics	Field, A.B.	Princeton U.	X						
NsG-436 (Gaugler) Study gravitational radiation	Misner, C.W. Weber, J.	U. of Md.	✓					X	
NsG-443 (Roman) Research related to an experimental test of general relativity	Alpert, D. Knoebel, H.	U. of Ill.	X						

S U P P O R T I N G R E S E A R C H

Project Designation and Contacts	Investigators	Affiliations	I					
			A	S	P	R	P	P
				P	A	P	F	B
NsG-471 (Ott)	Gold, T.	Cornell U.	✓	✓			X	
NsG-493 (Roman)	Gehrels, A.M.J.	U. of Ariz.	X					
NsG-503	Johnson, H.R.	Indiana U.	X					
NsG-546 (Roman/Ott)	Hiltner, W.A. Wilcock, L.	U. of Chicago Imperial College, London	X					

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TASKS	TECHNICAL MONITORS	S P R P					
		A	P	A	P	F	P B
Flight Research Center Prepare for UV stellar photography from aboard the X-15. Conduct engineering studies associated with the modifications to the X-15 to accommodate the slow tracking and photography equipment and make analog simulator and flight studies of the task to ascertain the piloting problems, display requirements, control requirements, reaction control fuel usage, and to establish operational techniques. Also, there will be studies of the man-machine combinations required to accomplish the star acquisition and tracking tasks involved in this experiment.	Thomas, L.P.	X					
Goddard Space Flight Center Theoretical study of ion-electron recombination. This study is aimed at extending our knowledge on problems of collision cross sections, types of possible reactions and the reaction rates.	Hess, W.N.	X				✓	
Theoretical studies of stellar structure will consider such problems as interior models for very massive stars and calculations on opacity sources in stellar atmospheres	Milligan, J.E.	X					
Develop statistical methods applicable to non-uniformly distributed observations for the purpose of (a) planning the distribution of observations, such as the locations of tracking stations; and (b) extracting the maximum of information from existing data.	Hess, W.N.						X

SUPPORTING RESEARCH AT NASA CENTERS

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TASKS	TECHNICAL MONITORS	I									
		A	P	A	P	S	P	R	P	F	P
Goddard Space Flight Center (Contd.)											
Research on low energy scattering of electrons by atomic and molecular systems.	Levine, A.	✓		✓		✓		✓			
A program directed toward an experimental study of the behavior of RF antennas and probes in a plasma and the development of ion composition and radiation detectors for studies of the lower ionosphere and the development of accurate and reliable instrumentation and techniques for spaceborne radio astronomy.	Stone, R.	✓			X						
Ground-based evaluation and test of instrumentation and antenna concepts for space radio astronomy; synoptic monitoring of solar and Jupiter radio emissions.	Stone, R.										
		X	✓	✓							
Jet Propulsion Laboratory											
Investigate the physical processes occurring in planetary atmospheres by measurement of intensity and line widths of millimeter wave emission from and through these atmospheres. Determine planet surface characteristics by means of emissivity mapping techniques.	Gray, F.B.	X		✓							
Using Coude focus spectrometers, extend our knowledge of the moon and the planets through ground-based observation and measurements. Determine the compositions, thermal structures and velocity fields in planetary atmospheres, and acquire knowledge on the characteristics of the lunar surface.	Gray, F.B.	X		✓							✓

SUPPORTING RESEARCH AT NASA CENTERS

TASKS	TECHNICAL MONITORS	I							
		A	P	A	P	R	P	P	P
Jet Propulsion Laboratory (Contd.)									
Develop the necessary techniques to calibrate spectrometric flight instruments for use in the vacuum UV portion of the spectrum. The development of UV sources, calibrated detectors and an improved vacuum chamber are initial tasks.	Thiele, C.	✓	✓					X	
Langley Research Center									
Study and extend current cosmological theory and correlate the theoretical and experimental results in order to identify the correct model universe. Also, studies will be made to determine the astronomical and astrophysical observations, yielding the most significant cosmological data, that are worthy of being done in a satellite and provide methods of data analysis.	Bird, J.D.								X

SOLAR PHYSICS PROGRAM

The objectives of the solar physics program are twofold: To advance our understanding of the sun's constitution and behavior; and to elucidate the physical processes by which the sun influences the earth. Since the sun is the nearest star, it offers unparalleled opportunities to acquire new observational knowledge of astrophysical phenomena, and to test theories. It is the only star on which we can directly observe structural features like sunspots or prominences, and the only one near enough to permit the study of its x-ray, gamma-ray or radio emission. However, the earth's atmosphere is nearly or completely opaque to solar radiation at wavelengths shorter than about 2900 Angstroms. In order to study the solar ultraviolet light, or x- or gamma-rays, it is necessary to carry our instruments above the atmosphere.

The space science program in solar physics has two major efforts in pursuit of these objectives: The Orbiting Solar Observatory (OSO), and the Advanced Orbiting Solar Observatory (AOSO). The OSO carries small, relatively simple instruments into orbit above the atmosphere to provide continuous, uninterrupted patrol periods of solar ionizing radiations. These radiations are subject to dynamic, unpredictable, transient variations which produce violent responses on the earth and in its vicinity. Hence, OSO plays a key role in discovering and explaining sun-earth relations.

The first of these spacecraft, OSO-I, was launched 6 March 1962, and provided useful data for more than a year. Observations obtained from it provide the only ultraviolet (100-400Å) spectrophotometric and x-ray flux (1-10Å) measurements made continuously for a period of several solar rotations. These data permitted the first comparison of the ionizing radiations of the quiet sun with active centers (facular plage) and solar flares, both in the chromosphere and corona. By OSO-I studies, many new facts were learned about solar x-rays. The x-ray emission of a chromospheric

flare usually varies in close step with its brightness in visible hydrogen radiation. Even when the visible sun is notably active, there persists some flux of x-rays, in proportion to the calcium facular area. Unanticipated pulses of x-ray emission were detected, which have not yet been identified with known visible light phenomena. Another OSO-I experiment measured for the first time the increase in net solar Lyman-alpha emission during a solar flare. A neutron detector on OSO-I established a very low upper limit on the emission of neutrons from the sun at quiet times and during small flares.

The simple instruments OSO can accommodate, however, do not by an order of magnitude or more, attain the optical resolution, pointing, or data handling capability necessary to fulfill the program's research objectives. The Advanced Orbiting Solar Observatory is being designed to meet these needs. When this refined space vehicle becomes operational, it will permit observations in the ultraviolet and x-ray spectral regions to almost the same precision possible with the greatest telescopes from the surface of the earth.

TECHNIQUES AND INSTRUMENTS

AVAILABLE:

Geiger tubes, proportional ionization chambers, scintillometers and photomultipliers are available to detect and measure energetic solar photons. Image forming telescopes exist for use down to about 100 Angstroms, to permit structure analysis of the sun. Dispersive analyzers (spectrographs) permit the detailed study of spectral line profiles in the ultraviolet to about 1000 Angstroms and lesser resolution is possible to about 100 Angstroms using diffraction gratings. Crystal spectrometers can be used to examine the line spectrum of the soft x-rays, but in this region most investigations are carried out with either broad-band filtered detectors, or with proportional counters and pulse height analyzers. Two-axis stabilization of experiments on Aerobee rockets has

been a reliable achievement for some years. Three-axis stabilization has been found successful in the first Orbiting Solar Observatory (OSO-I); which performed within specifications of about one minute of arc. OSO-B is expected to supplement pointing to this precision with a raster scan with far UV or even x-ray detectors behind simple geometrical collimators. Ground-based radio telescopes are available for observing the sun through the appropriate windows of the earth's atmosphere. At frequencies below the critical frequency (defined by the ionospheric F_2 layer peak electron densities), an orbiting radio telescope becomes necessary. Antennas for such observations are at present restricted to simple dipoles. Energetic charged particles emitted from the sun (solar protons, solar wind) are observed with instruments described in the Particles and Fields discipline, Part V.

UNDER DEVELOPMENT:

An advanced version of an Orbiting Solar Observatory, with a fine pointing capability of ± 5 seconds of arc to the center of the sun or any desired offset position within a 40 minutes of arc square centered on the center of the sun and coarse offset pointing of ± 1 minute of arc within a 10 degrees of arc square centered on the center of the sun is being developed. A generation of electromagnetic and energetic particle detectors with sufficient sensitivity to make use of this improved OSO is also being developed.

S A T E L L I T E S

Project Designation and Contacts	Experimenters	Affiliations	I					
			A	S	P	R	P	P
				P	A	F	F	B
INTERPLANETARY EXPLORERS (IMP-A, B&C) (Freeman/Ehrlich)								
Planar trap ion-electron detector for plasma measurements in thermal energy range (0 - 10 ev)	Serbu, G.P. Bordeau, R.	GSFC	✓			X	✓	
ORBITING SOLAR OBSERVATORY (OSO-B) (Smith/Halpern)								
Arrival direction and energies of pri- mary cosmic rays (50 Mev and up)	Leavitt, C.P.	U. of N. Mex.	✓	X				
Search for solar gamma ray flux (0.1 Mev to 3 Mev)	Frost, K.	GSFC		X				
Solar UV spectrophotometry (500-1500Å) and spectroheliograph	Goldberg, L. Reeves, E.M. Parkinson, W.H. Liller, W.	Harvard U.				X		
Solar X-ray emissions. Pinhole scan of sun (8-20Å and 44-60Å). Monitor X-ray bursts (2-8Å, 8-20Å, and 44-60Å)	Chubb, T. Kreplin, R.	NRL				X		

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Project Designation and Contacts	Experimenters	Affiliations	S P R P A P A P F P B
<u>OSO-B (Contd.)</u>			
White light coronagraph measurements to study the structure of the outer solar atmosphere & its relation to the interplanetary medium	Tousey, R. Purcell, J.D.	NRL	X
Solar UV scanning (304Å, 584Å and 1215Å)	Tousey, R. Purcell, J.D.	NRL	X
<u>OSO-C (Smith/Halpern) (Pointed Section)</u>			
Monochromator measurements of solar extreme UV photon fluxes (1300 to 60Å)	Hinteregger, H.E.	AFCRL	X
Studies of the solar spectrum (1 to 400Å)	Lindsay, J.C. Neupert, W.M. Behring, W.E. White, W.A.	GSFC	X
Study solar X-rays (2-8Å, 8-20Å, 44-60Å)	Chubb, T.A.	NRL	X
Map white light corona and scan solar UV	Tousey, R.	NRL	X

S A T E L L I T E S

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Project Designation and Contacts	Experimenters	Affiliations	A	S	P	R	P	P	B
<u>OSO-C (Back-up Experiment) (Contd.)</u>									
Distinguish between emissions from a thermally excited coronal plasma and the Bremsstrahlung X-rays produced by fast electrons into a relatively low temperature corona	Friedman, H. Chubb, T.A.	NRL							
				X					
<u>OSO-C (Wheel Section)</u>									
Study energy spectrum and time dependence of bursts from the sun (15 to 600 kev)	Peterson, L.E.	U. of Calif. LaJolla							
				X					
Measure solar X-ray flux (8-20Å)	Teske, R.G.	U. of Mich.							
				X					
Measure charge and energy spectra of particles of energies 3.3 Mev/nucleon	Hafner, E.M. Kaplon, M.F.	U. of Rochester							
				✓				X	
Gamma ray astronomy (above 100 Mev)	Kraushaar, W.L.	MIT							
				✓					

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Project Designation and Contacts

Experimenters

Affiliations

OSO-D (Pointed Section) (Smith/Halpern)

Experiment to distinguish between emissions from a thermally-excited coronal plasma and the Bremsstrahlung X-rays produced by fast electrons injected into a relatively low temperature corona

Friedman, H.
Chubb, T.A.

NRL

X

This experiment will incorporate a long wavelength spectrometer capable of scanning the spectrum of a selected portion of the solar disc between the wavelength limits 300 to 1300 angstroms

Goldberg, L.
Reeves, E.M.
Parkinson, W.H.

Harvard Col.
Observatory

X

A) obtain a map of the sun in X-rays with an angular resolution of better than two minutes of arc; B) extend observation of X-ray emission of the solar corona out to distances of about 1 solar radius; C) perform a preliminary spectrum analysis of the radiation emitted from the various regions of the sun in three broad spectrum ranges about 8 and 20Å; and D) study the temporal variations of solar X-ray emission with a time resolution of the order of minutes (share space with the NRL Bragg crystal spectrometer).

Giacconi, R.

American
Science &
Engineering
Inc.

X

S A T E L L I T E S

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Project Designation and Contacts	Experimenters	Affiliations	A	S	P	R	P	P	B
<u>OSO-D (Wheel Section)</u>									
A) Survey the directional intensity of non-solar cosmic X-rays; B) obtain a rough survey of their spectral composition between 10 and 0.1Å; C) distinguish between the stellar and the syncratoron component; D) correlate regions of strong intensity with optical and radio objects of special interest; and E) study auroral X-rays	Giacconi, R.	American Science & Engineering Inc.	X						
Study the soft X-ray region of the solar spectrum over a wider wavelength range than has hitherto been attempted at one time (1.2-3.6Å, 3-9Å, 6-18Å, 44-55Å, and 44-70Å)	Stewardson, E.A. Boyd, R.L.F.	Leicester U. & U. College, London	X						
Detect and identify electrons with energy greater than 60 kev and protons with energy greater than 2 Mev	Waggoner, J.A. Bloom, S.D. Schrader, C.D. Kaifer, R.	U. of Calif. Livermore	✓					X	
Solar HeII resonance emission (303.8Å) The experiment will provide accurate independent determination of the absolute value of the quiet sun component of the solar flux together with data on the short-term enhancement due to localized solar activity.	Boyd, R.L.F.	Univ. College London	X						

S A T E L L I T E S

Project Designation and Contacts	Experimenters	Affiliations	I				
			S	P	R	P	P
<u>OSO-D (Wheel Section) (Contd.)</u>							
Solar radiation monitoring (8 to 16Å, 2 to 8Å, 0.5 to 3Å, and 0.1 to 1.6Å)	Chubb, T.A. Kreplin, R.W. Friedman, H.	NRL					
X-ray spectroheliograph (back up experiment)	Stewardson, E.A. Boyd, R.L.F.	Leicester U. & U. College, London					
<u>OSO-E (Pointing Section) (Smith/Halpern)</u>							
X-ray spectroheliograph (8 to 18Å and 3 to 9Å)	Stewardson, E.A. Boyd, R.L.F.	Leicester U. & U. College, London					
Continuation of the studies of the solar spectrum from 1 to 400Å	Lindsay, J.C. Neupert, W.M. Behring, W.E. White, W.A.	GSFC					
<u>OSO-E (Wheel Section)</u>							
Self-reversal of the solar Lyman-alpha line using an atomic hydrogen adsorption cell	Blamont, J.	U. of Paris					

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Project Designation and Contacts	Experimenters	Affiliations	I					
			A	P	A	P	F	P
<u>QSO-E (Wheel Section) (Contd.)</u>								
This experiment will provide absolute indices of solar activity by routine X-ray measurements using sets of standardized X-ray ion chamber photometers	Chubb, T.A. Kreplin, R.W. Friedman, H.	NRL	X			✓		
Solar low energy gamma ray measurements (5 kev to 150 kev region)	Frost, K. Horstman, H. Rothe, E.	GSFC	X					
<u>ORBITING GEOPHYSICAL OBSERVATORY (OGO-A&B)</u> <u>(Schardt/Ashworth)</u>								
Measure the cosmic noise at two fixed frequencies in the 2 to 4 Mc/s range	Haddock, F.T.	U. of Mich.	X	✓				
Measure solar cosmic ray protons (10 to 90 Mev) and solar X-rays using scintillation detectors	Anderson, K.A.	U. of Calif. Berkeley	✓				X	
Detect and measure positrons (0 to 3 Mev) and monitor solar proton bursts (30 kev to 1.2 Mev)	Cline, T.L. Hones, E.W.	GSFC Institute for Def. Analysis	✓				X	

S A T E L L I T E S

Project Designation and Contacts	Experimenters	Affiliations	I					
			A	P	S	P	R	P
<u>OGO-C&D (Fellows/Ashworth)</u>								
Measure rigidity and charge spectrum of galactic and solar cosmic rays	Webber, W.R.	U. of Minn.	✓					X
Measure the cosmic noise at two fixed frequencies in the 2 to 4 Mc/s range	Haddock, F.T.	U. of Mich.	X	✓			✓	
Determine time variations in solar X-ray emission using an ionization chamber (0.5 to 3Å, 2-8Å, 8-16Å, and 44-60Å)	Kreplin, R.W. Chubb, T.A. Friedman, H.	NRL			✓	X	X	
Monitor the spectral distribution of energy (170 to 1700Å)	Hinteregger, H.E.	AFCRL	✓			X	X	

OTHER FLIGHT EXPERIMENTS

II-12

Project Designation and Contacts	Experimenters	Affiliations	I					
			A	P	A	P	F	P
<u>BALLOON (Roman/Ehrlich)</u>								
Anisotropy of gamma rays from 3 to 30 Mev	Overbeck, J.	MIT	X					
<u>BALLOON (Smith/Ehrlich)</u>								
Charged particle detector sensitive to the L group of nuclei ($3 \leq Z \leq 5$), relativistic particles (0.72), protons corresponding to 0.35	Kaplon, M.	U. of Rochester		X				
<u>BALLOON (Smith/Ehrlich)</u>								
Record the intensity, degree of polarization, and polarization angle of coronal light from a few minutes of the solar limb to about 6 solar radii.	Newkirk, G.	UCAR						
<u>BALLOON (Freeman/Ehrlich)</u>								
Measure the charge and energy spectra of cosmic rays at several geomagnetic latitudes during the solar minimum period	Webber, W.R. Winckler, J.R. Waddington, C.	U. of Minn.						

SOUNDING ROCKETS

S O U N D I N G R O C K E T S			I					
Project Designation and Contacts	Experimenters	Affiliations	S P R P					
			A	P	A	P	F	P B
<u>AEROBEE 150</u>								
4.22(Smith) Flight test solar UV OSO-B experiment to measure intensity of radiation coming from the sun (500 to 1500Å)	Liller, W.	Harvard U.						
				X				
4.24 (Smith/Halpern) Measure the energy of the solar spectrum (between 50 and 1500Å)	Rense, W.A.	U. of Colo.						
				X				

S U P P O R T I N G R E S E A R C H

<u>Project Designation and Contacts</u>	<u>Investigators</u>	<u>Affiliations</u>	<u>I</u>					
			<u>S</u>	<u>P</u>	<u>A</u>	<u>P</u>	<u>P</u>	<u>P</u>
R-102 (Smith) Support of a worldwide ground-based network to observe the sun throughout a 24-hour period	Lincoln, J.V.	CRPL						
				X				
R-107 (Smith) Development of components and instrumentation for AOSO satellite	Friedman, H.	NRL						
				X				
NASr-5 (Smith) Design, construct, and test a prototype, high-speed, high-resolution, rocket stigmatic spectrograph useful in the region 1000 to 3000 Å	McAllister, H.	U. of Hawaii						
						X		
NASr-86 (Smith) Investigate spectrographically, in space environment, the solar UV radiations	Rense, W.	U. of Colo.					X	
NsG-263 (Fellows) Quantum mechanical calculations and studies on atomic systems of astrophysical interest	Matsen, F.A.	U. of Texas						
							✓	X

S U P P O R T I N G R E S E A R C H

Project Designation and Contacts	Investigators	Affiliations	I					
			A	P	A	P	F	P B
NsG-120 (Smith) Investigate generation and detection of ultra-long X-rays and quantitatively study their interactions with matter	Wyckoff, R.	U. of Ariz.	X					
NsG-176 (Smith) Theoretical investigation of the interaction of solar flare particles with coronal plasma	Oster, L.	Yale U.						
NsG-288 (Smith) Ground-based investigation of solar phenomena and solar monitoring	Miller, R.A.	Manila Obsv.	X					
NsG-311 (Smith) Investigate techniques for rocket-borne spectrographic studies of the solar UV spectrum (950 to 1050Å) and use of a prototype instrument for laboratory studies of the absorption of such radiation by nitrogen and oxygen	Violette, T.D.	Western St. College of Colo.						
NsG-320 (Smith) Monitor solar chromosphere	Gaizauskas, V.	Dominion Obsv. Canada	X					

S U P P O R T I N G R E S E A R C H

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Project Designation and Contacts	Investigators	Affiliations	
NsG-404 (Smith) Design of a coronagraph for advanced satellite employment	Newkirk, G.	UCAR	X
NsG-438 (Smith) Definition of atomic spectra in the UV to aid in interpretation of solar spectra	Goldberg, I.	Harvard U.	X
NsG-471 (Ott) Theoretical and experimental study of ionized gaseous regions in interplanetary space.	Gold, T.	Cornell	X

SUPPORTING RESEARCH AT NASA CENTERS

TASKS	TECHNICAL MONITORS	I S P R P A P A P F P B					
		A	P	A	P	F	P B
Ames Research Center							
Using a combination of narrow bandpass birefringent filters and a recently developed filter-absorber based on the normal Zeeman effect, together with electronic image intensification techniques, instrumentation will be developed which will be capable of producing solar magnetograms with a time resolution better than ten seconds.	Bader, M.		X				
Conduct studies of solar magnetic fields with ground-based equipment and correlate the information obtained with simultaneous optical and radio frequency and magnetic field measurements made on the ground and from earth satellites and deep-space probes.	Bader, M.		X				
Conduct theoretical studies of models for solar and stellar atmospheres to determine chemical composition, structure, atomic processes, and dynamic behavior.	Spreiter, J.R.	✓	X				
Goddard Space Flight Center							
Task objective is to learn more about the solar flare phenomenon that is, the energy storage mechanism, the energy release, and the energy transport phenomenon; and apply new knowledge concerning solar flares to the improvement of solar flare prediction criteria.	Lindsay, J.C.						X

SUPPORTING RESEARCH AT NASA CENTERS

TASKS	TECHNICAL MONITORS	I									
		A	P	A	P	A	P	F	P	F	P
Goddard Space Flight Center (Contd.)											
Both soft X-rays and vacuum UV radiation are absorbed by the earth's atmosphere making it impossible to carry out terrestrial observations in the wavelengths between 1 and 2000Å. Orbiting spacecraft having suitable detectors and means for transmitting the data to earth are required for long-term observations. There is a need for a space-borne solar image reproduction system consisting of a TV camera equipped with a special camera tube and optics which will respond to the wavelength region between 1 and 2000Å. The first such system will be designed to operate in the 1 to 100Å region.	White, W.A.										
Theoretical studies in stellar and solar physics aimed at understanding the mechanism by which the atoms interact with each other and with radiation and understanding our environment in relationship to the solar system and eventually gaining some control over our environment by this knowledge.	Hess, W.N.										
Development of a sun sensor designed to point the AOSO with great precision.	Raskin, W.										
Ground-based evaluation and test of instrumentation and antenna concepts for space radio astronomy; synoptic monitoring of solar and Jupiter radio emissions.	Stone, R.										

X / ✓

SUPPORTING RESEARCH AT NASA CENTERS

TASKS	TECHNICAL MONITORS	I S P R P A P A P F P B
Jet Propulsion Laboratory		
Develop the necessary techniques to calibrate spectrometric flight instruments for use in the vacuum UV portion of the spectrum. The development of UV sources, calibrated detectors and an improved vacuum chamber are initial tasks.	Thiele, C.	✓ X

PLANETARY ATMOSPHERESDEFINITION:

The Planetary Atmospheres discipline covers the NASA research on the atmospheres of the earth, the other planets, and the moon. Also treated are ensembles of gases and particulate matter found in space, including comets, meteors, and meteorites. Studies of the earth's atmosphere within the planetary atmospheres discipline are concentrated in the region above that treated by synoptic meteorological techniques, and they share with meteorology a mutual interest in the ozone layer at approximately 30 km. At this time studies of the atmospheres of other planets are directed at those of Mars and Venus and include all aspects of these atmospheres.

OBJECTIVES:

The principal objectives of the program are to determine and understand the origins, evolution, nature, spatial distribution, and chemical and dynamical behavior of the atmospheres of the earth, planets, moon, comets and the sun, and their relations to the medium of interplanetary space.

DESCRIPTION:

This study of the earth's atmosphere is primarily concerned with the region of the atmosphere above approximately 30 km. Aside from the variations in moisture content, temperature and pressure as altitude increases, a significant departure from the sea level characteristics occurs at about 30 km where ozone becomes important in determining the behavior of this region of the atmosphere. Here, the behavior and characteristics of the atmosphere are determined by a trace constituent not significant at lower levels. Another significant region begins at a somewhat higher altitude where the bottom of the ionosphere, the D-layer, makes its appearance. The characteristics of the ionosphere

are greatly affected by the free ions and electrons which are present. Interactions with electromagnetic energy occur that are not present at lower altitudes. In recent years, the use of the word "aeronomy" to describe the study of the chemistry and physics of this and higher regions has become quite commonplace and is used to emphasize the differences in the atmosphere and the techniques of investigation that must be used for these upper regions.

Solar electromagnetic energy is the major energy input to planetary atmospheres. Energetic particles, electromagnetic and gravitational forces, and micrometeorite bombardments are lesser factors; but are not so insignificant that they can be neglected. The effects of energy inputs are apparent in the weather phenomena of the lower atmosphere and in various ionospheric phenomena at higher altitudes. Daily, seasonal, and solar cycle dependencies have been observed and studied, as well as the effects of solar flares and the ensuing swarms of solar protons. The complexity of the phenomena and physical limitations in the ability to perform "in situ" measurements are such that investigations of the upper atmosphere are a considerable distance from being synoptic in extent. Despite the paucity of accumulated observations, however, we have arrived at some understanding of the phenomena of the upper atmosphere.

Considerable progress has been made in measuring the extent and approximate composition of the earth's atmosphere. Even here, however, the bulk of our knowledge concerns the temperate and auroral latitudes, and few measurements have been made in the equatorial or polar regions. Also, progress has been made in understanding the theory of the variation of composition (molecular or atomic weight) with altitude as controlled by gravitational forces, diffusion, temperature, and solar energy. Quantitative verification, however, especially for the polar regions, remains as a goal of later years.

Information about the atmospheres of Mars and Venus has been limited to that obtained by ground-based optical and

radio astronomy. These methods are now being extended by observations made from high altitude balloons and aircraft, and from planetary flyby missions. Early acquisition of new experimental data of the atmospheres of Mars and Venus, either from astronomical or from "in situ" measurements, will be of tremendous value in helping to decide among the various competing theories attempting to account for the characteristics of the atmospheres of these two planets.

THE EARTH'S ATMOSPHERE

In recent years the investigation of the earth's atmosphere has proceeded vigorously enough to provide rough models of the principal characteristics and properties to several thousand kilometers altitude. The physical structure (i.e. pressure, density, and temperature), and the chemical composition of neutral and ionic species have been determined in a general way, but variations in the upper atmosphere with time and geographical position remain quantitatively unknown. The importance of "trace" constituents in determining the characteristics of certain regions is recognized, and acceptable theories have been developed that account for their presence, i.e. the ozone layer centered near 30 km in altitude, the presence of NO^+ ion at higher altitudes, and the presence of O^+ still higher.

Our detailed knowledge of the above, however, is quite inadequate in respect to time and geographical variations. This knowledge must be acquired before it will be possible to understand the exact processes involved in the response of the atmosphere to incident solar energy.

Atmospheric Structure

The physical parameters describing the structure of the atmosphere are temperature, pressure, and density. Measurements of these structural parameters above balloon altitudes (35 kilometers) have become possible only since the advent of rockets and satellites. From sea level to 100 kilometers both pressure and density decrease by a factor of ten for

an altitude increase of 16 kilometers. Structure measurements from balloon altitudes to about 200 kilometers have been made by means of a number of techniques; grenade, falling sphere, and vacuum gauges--all utilizing vertical sounding rockets. Above 200 kilometers, satellite drag observations have given information on atmospheric density and temperature, and their temporal variations. More recently direct, in situ measurements of density and composition have been made on Explorer XVII. For example, a variation in the atmospheric density of at least a factor of 7 at 400 kilometers has been measured. In addition, extensive data on the number density of helium molecular nitrogen and atomic oxygen were obtained over an altitude region of from 260 to 930 kilometers. From satellite data it appears that the structural parameters of the upper atmosphere depend strongly on solar activity as demonstrated by correlations with solar decimeter radiation. In this region, the atmosphere is essentially isothermal, and the temperature has been determined from scale heights of measured density distribution for a known mean molecular weight, as well as from rocket sodium release experiments. Direct measurements of charged particle temperatures, however may not be representative of the neutral gas temperature since there is evidence for departure from thermal equilibrium.

Composition

The composition of the upper atmosphere must be known if one is to understand the physical structure of the atmosphere, the chemical processes that occur in the atmosphere, and many other atmospheric effects. Except for varying quantities of water vapor and the photochemically produced layer of ozone near 30-km altitude, the atmosphere is rather well mixed and homogeneous in composition up to about 100 km altitude. Above this level, oxygen becomes increasingly dissociated into atomic form, due to photo-dissociation. Further, at about the same altitude (perhaps 110 km), the effects of diffusive separation in the gravitational field begin to be of importance, and this causes the concentration of various atmospheric constituents at altitudes above this level to decrease with altitude at rates which are greater

for the heavier constituents. Atomic oxygen, being lighter than molecular nitrogen, therefore increases in relative concentration with altitude, and finally comes to predominate over nitrogen above 200 or 300-km altitude. However, mixing, diffusion, and large scale transport all affect this process, to a degree which is not at present well understood, and the subject still requires full exploration.

Just as atomic oxygen comes to predominate over molecular nitrogen above some level, helium, a minor atmospheric constituent in the lower atmosphere, finally comes to predominate over atomic oxygen, at an altitude (near 1000 km) that varies with the temperature of the upper atmosphere, and hence with phase of the sunspot cycle, solar activity, time of day, and probably latitude. Further, in the upper atmosphere, photochemistry provides a source of atomic hydrogen, and above about 3000 km, this constituent predominates over helium. Hydrogen, in fact, extends far out from the earth, and produces a geocorona.

In addition to the neutral atmospheric constituents, there are ionized constituents that are associated with the various ionospheric regions above about 50-km altitude. In general, there is a complicated photochemistry associated with the ionic species throughout the ionosphere. Further, above the region of peak ion concentration near 300-km altitude, diffusion is very important. Molecular ions are in general important in the lower ionosphere, whereas atomic ions predominate near the ion peak and above. Also, transitions occur in the ion composition. Near the maximum of the sunspot cycle O^+ ions predominated at the ion peak on up to about 1000 km, He^+ ions from 1000 to 3000 km and H^+ ions at still higher altitudes. The altitude ranges for these various ions varies strongly with atmospheric temperature and hence with solar activity, and the helium ion region disappears near the minimum of the sunspot cycle. Although the above-described pattern of ionic distribution is believed to exist, there is a great need for quantitative data to make clear the spatial and temporal distributions in some detail, so that the physics and chemistry of the ionosphere can be understood.

Atmospheric Motions

The atmosphere is a large heat engine, since heat is applied in some regions and other regions are cooled, and the result is motion of air. The main source of energy at all levels is the sun's radiation, and this is absorbed most strongly at low latitudes; other sources of heating at high latitudes in the upper atmosphere are auroral particles and the release of chemical energy when atomic oxygen is carried downward and forced to recombine. The motions induced in the atmospheric heat engine are therefore complex, and in the upper atmosphere they are affected by changes in solar activity as well as varying with the season and time of day. Moreover, these various motions have important effects on conditions in the upper atmosphere, since, for example, winds in the E-region carry ions and electrons across the earth's magnetic fields and generate electric currents and corresponding changes in the magnetic field, vertical motions in the D-region transport ionized layers up and down, ozone concentrations are affected by transport from regions of ozone production, etc. In addition, at levels between about 70 and 110 km tidal motions become very strong, and there is evidence for gravity waves in this same region that produce strong wind shears and turbulence. The mechanisms for these tidal oscillations and gravity waves are poorly understood. On a smaller scale of motion are the atmospheric eddies that constitute turbulence. These are important in transporting heat or trace constituents locally. (See section on "Diffusion and Turbulent Transport.")

Up to about 70 km, winds can be observed by tracking falling clouds of chaff by radar or by tracking parachute-borne rocketsondes. Up to about 90 km rocket grenade observations can give winds, as well as temperature. A frequently used method that gives winds from 80 to over 200 km is the luminous rocket trail, and recent developments have made it possible to conduct such experiments throughout the night as well as during twilight. The most abundant data in the 70 to 90 km region has come from tracking meteor trails by

radar (in England and Australia), though at the present time this kind of ground-based experiment is receiving very little attention in the U.S. or elsewhere.

It is clear that many of the important phenomena in the upper atmosphere can only be explained by considering the effects of air motions, so a knowledge of these motions is fundamental to an understanding of the atmosphere. In addition, there is now some evidence that changes in the circulation patterns at high levels can on occasion propagate downwards, as, for example, during periods of the "breakdown" of the polar vortex in the late winter. Therefore there may be important but unexplained links between the upper atmosphere and the lower atmosphere, and these may have implications to long range predictions of the weather. Such coupling mechanisms between upper and lower atmosphere are being studied by means of the new data being gathered by rocket wind (and temperature) techniques.

Solar Radiation Absorption

The earth's upper atmosphere above about 100 kilometers is now known to be most strongly affected by the absorption of solar extreme ultraviolet and X-rays (XUV) of wavelengths ranging from about 1750 Å to 1 Å. The direct and indirect effects of this absorption are responsible for most of the normal thermospheric temperature rise, the vertical variation of the neutral gas density and composition, the creation of the earth's ionosphere with its normal spatial and temporal variations of electron density and ionic composition.

Our knowledge of the general importance of XUV absorption has been put on firm grounds recently. Existing data on the now most significant details, however, are still quite inadequate. Continuous monitoring of the incident solar XUV fluxes in sufficient detail and with better accuracy is needed for quantitatively reliable theoretical descriptions. The systematic evolution of the latter should lead to some capability of predicting rather than merely describing the spatial and temporal variation of the atmospheric structure.

This systematic evolution requires a more vigorous pursuit of a supporting program of vertical probing rockets with improved instrumentation in addition to the aforementioned program of XUV input monitoring by satellites.

Airglow

The airglow in the upper atmosphere represents the emission of electromagnetic radiation from the atomic and molecular constituents. The primary energy for such emission comes from the sun especially resonance excitation of the dayglow. A major portion of the luminescence is of a chemical nature, although ionic recombination and bombardment by energetic particles also contribute to the airglow. Most of the information about the airglow has been obtained for the night airglow in the visible region of the spectrum. The main emissions include the atomic lines of oxygen at 5577 Å and 6300 Å and the doublet D radiation of sodium at 5890 Å. Molecular radiation has also been observed particularly from the OH radical. From these observations the mechanisms for the radiation have been derived. The seasonal and the latitudinal variations of the radiation have been studied and are useful in estimating the variation of the concentration of atomic action in the upper atmosphere and atmospheric motions. Temperatures of the high atmosphere have been obtained from rotational and vibrational bands.

Observations of the day airglow in the ultraviolet and visible and the ultraviolet night airglow have been made possible by placing detectors on sounding rockets and satellites. The world-wide distribution of hydrogen and helium has been under study by monitoring the Lyman Alpha of both these atoms. Ultraviolet spectrophotometer measurements have detected some new lines due to oxygen and possibly nitrogen, which may subsequently be used for world-wide mapping from satellites. From airglow radiation several atmospheric characteristics may be studied. These include atmospheric composition, the identification of minor constituents, the distribution of certain atoms and molecules,

the atmospheric temperature, the region of energy absorption or emission, and the detection and an analysis of chemical and ionic reactions.

Probably of great importance is the fact that observations from satellite vehicles may be obtained in a region remote from the satellite, so that distribution of constituents and the energies in the region of the lower ionosphere may be studied from satellite vehicles. In a similar way, the polar regions and the aurora may be investigated as well as the atmospheres of the near planets.

Aurora

The bombardment of the upper atmosphere by energetic particles produces many significant terrestrial effects. Principal among these is the well-known (but little understood) phenomenon of aurora borealis and its southern counterpart, the aurora australis. These and many other concomitant radio, geomagnetic and aeronomical effects are caused by the excitation and ionization of localized regions of the upper atmosphere by energetic electrons and protons guided to those regions by the earth's magnetic field. Despite many years of ground-based studies, and some rocket and satellite studies, there is a tremendous lack of knowledge of the origin, nature and energy flux of the streams of bombarding particles, or of the accelerating and precipitating mechanisms responsible for their deposition into the earth's atmosphere. It seems extremely likely that only concentrated studies of aurora by satellites and rockets can explain this phenomenon in any detailed quantitative sense.

In addition to the fluctuating and relatively localized bombardment by auroral particles, cosmic rays of galactic origin bombard the earth's atmosphere continuously. These cosmic rays produce ionization in the lower D region, thereby contributing significantly to the absorption of radio waves in the upper atmosphere. Cosmic rays of solar origin usually are not sufficiently intense to have marked geophysical

effects, but on rare occasions (typically only a few days each year) major outbursts of solar cosmic rays bombard the upper atmosphere, creating major radio disturbance at polar latitudes and a potential hazard to any astronaut exposed to the bombardment. For these reasons, it is important to study the energetic particles of the solar and galactic cosmic ray type, as well as of the auroral type.

Diffusion and Turbulent Transport

The two processes by which sensible heat, momentum, and minor constituents of the atmosphere can be transported (in addition to transport by winds) are molecular diffusion and turbulent or eddy diffusion. In the lower atmosphere, below about 100 km, turbulent diffusion dominates over molecular diffusion in all but the most transitory and small-scale situations. However, at about 105 km, as shown by rocket trail experiments, there is a remarkably abrupt transition from turbulent to molecular diffusion, and above this level the transport and distribution of all the permanent constituents of the upper atmosphere are predominantly determined by molecular exchange processes (though large scale motions or winds also must play a part). This explains the fact that above about 105 km each constituent of the atmosphere with a mean life of more than a few days (that is, O, O₂, N₂, H, He, A, etc.) will be distributed in the vertical with its own particular scale height, as if it were alone, and as a result the heavier constituents, such as N₂ and A, decrease more rapidly with height than the lighter constituents, such as H and He. The laws governing diffusive (molecular) equilibrium have apparently been remarkably successful in predicting the composition of the high atmosphere up to 1000 km and above, given a knowledge of composition at 100 to 110 km and the temperature distribution above that.

The theory of turbulent diffusion, as applied to the atmosphere below 100 km, is very inadequate in describing the transport and mixing processes that take place there. This is apparently due to the fact that eddy diffusion takes

different forms, depending on the thermal stability and wind shear (or vorticity) of the atmosphere, and the treatment of eddy diffusion varies with the "scale" of the process being considered. Some important theoretical advances have been made, but in the last analysis most treatments of upper atmosphere turbulence are empirical, and rely on observations of the transport and diffusion of artificial tracers, such as luminous clouds or trails produced by rockets (for small scale studies), or of long lived radioactive isotopes from nuclear explosions (for large scale studies, that probably involve the general circulation as well as turbulent transport). Since an understanding of such transport processes is fundamental to our knowledge of the structure and composition of the upper atmosphere, and also to an assessment of the potential hazards of pollution of the atmosphere by man-made injections of gases and dust, it is important that both theoretical and experimental studies of this subject be continued.

ATMOSPHERE OF MARS

The chemical and physical characteristics of the Mars atmosphere are of great scientific interest, both in their own right and with respect to the possible existence of indigenous life forms. Of special interest is the determination of the extent of atmospheric shielding of the planet's surface from ultraviolet radiation.

Recent spectroscopic observations of Mars have cast serious doubt upon previously accepted concepts regarding the composition and density of its atmosphere. Further observations are urgently needed to clarify these discrepancies.

The possible existence and properties of a magnetic field, an ionosphere, and particle belts should also be investigated.

ATMOSPHERE OF VENUS

The atmosphere of Venus is especially interesting. A study of its properties, both physical and chemical, may provide important information concerning the history of the solar system. Knowledge of the characteristics of the atmosphere also is required for the design of spacecraft which will be operating in the atmosphere or landing on the planet's surface. If the surface temperature is of the order of 700°K, as seems very likely now, equipment for the study of the lower atmosphere and surface must be designed to operate at high temperatures.

A study of the ultraviolet spectrum of the planet's atmospheric night-sky emission and daytime emission and absorption will give information on the presence of traces of ozone, molecular oxygen and nitrogen, atomic oxygen, and water vapor. Some of these observations may be made from high-altitude balloons, rockets, earth satellites and ground-based observatories.

Results from the December, 1962 Venus fly-by of Mariner II indicate that the planet has little or no intrinsic magnetic field nor trapped radiation belts. Radiometer scans of the planet's disk indicate, by the finding of unquestionable limb darkening, that the radiative properties of Venus can not be explained on the basis of a highly active ionosphere. The greenhouse and aeolosphere atmospheric models remain as possibilities. The decisive confirmation or refutation of these theories would be of great value.

The atmosphere below the cloud cover is still almost completely unknown. The planet's direction and rate of rotation is also uncertain.

ATMOSPHERE OF THE MOON

Virtually nothing is known about the lunar atmosphere from direct observation. Its density is uncertain by several

orders of magnitude, and its composition and distribution are matters of speculation. The lunar atmosphere is thought to be mainly derived from generation of gases by chemical and physical processes in or on the lunar body and from accretion of the solar plasma. The primordial atmosphere presumably existing at the time of formation of the moon is considered relatively unimportant due to the rapid loss of particles which, in a Boltzmann energy distribution, acquire escape velocity, and to the "sweeping" effect of the solar wind.

Measurements of density, distribution, and relative abundance of neutral and ionized components of the lunar atmosphere may provide information of fundamental scientific importance such as the following:

1. Determination of the elemental identity and relative abundance of constituents of the solar wind, discharged and concentrated in the lunar gravitational field.
2. Determination of charged particle density distribution in the vicinity of the moon, especially in regard to possible modulation by any lunar magnetic field.
3. Determination of isotope ratios of elements, e.g. $\text{Ne}^{20}/\text{Ne}^{22}$ and $\text{Ar}^{36}/\text{Ar}^{40}$, of cosmological significance.
4. Information regarding the formation and chemical composition of the lunar body.
5. Information regarding radioactivity on the moon.
6. Information regarding volcanism on the moon.

Recognizing the extremely tenuous nature of the lunar atmosphere, it is urgent that measurements of this type be carried out as early as possible in the program of lunar exploration while contamination due to retro-motor fuel is at a minimum.

INTERPLANETARY SPACE

Experimental studies of the interplanetary medium will contribute significantly to our knowledge of the sun's physical properties and of the processes through which the sun affects the planets. For example, measurements, in interplanetary space, of the magnetic fields, plasmas and energetic corpuscular radiation should provide a great deal of this information. It is known that these entities, found in interplanetary space, are produced or affected by the sun and that they are responsible for numerous phenomena observed at the earth.

Interplanetary and Atmospheric Dust

Dust and meteors entering planetary atmospheres may have a measurable effect upon them by contributing minor constituents to the composition and by ionizing or supplying ionizing atoms to affect planetary ionospheres. It has been suggested that meteoric dust is the major cause for the characteristic pattern of worldwide rainfall. Interplanetary dust, as observed from measurements of the zodiacal light and possibly the Gegenschein, is a major constituent of the interplanetary space. The distribution, composition, physical structure, and dynamics of dust in the interplanetary space should be determined. The mechanisms and chemistry for the creation and growth of dust are also of fundamental astrophysical interest in studying the origin of the solar system.

Comets

It is generally considered that a comet is a conglomerate of frozen gases and dust of low molecular or atomic weight constituents. Comets are accompanied by gaseous envelopes or atmospheres as a result of solar heating. Studies of the coma and tail are of considerable interest for the clues found concerning the composition of the comet. It is considered possible that comets may be the natural nuclei of stars and planets.

TECHNIQUES AND INSTRUMENTS AVAILABLE:

A wide variety of instruments and techniques are used or are being developed for use in investigations of the atmospheres of the earth and other planets. The most important of these instruments and techniques are listed below.

The temperature of the atmosphere has been and is being measured by (a) thermistors at relatively low altitudes; (b) the speed of sound by exploding grenades; (c) by spectroscopic methods from the broadening of lines and bands of atmospheric emission, or fluorescence of released gases; and, (d) by the velocity distribution function of ions, electrons, or neutral particles. Temperature is also determined by (a) the distribution of pressure using the hydrostatic equation; (b) with the Rayleigh equation to determine Mach number using a pitot-static pressure gage configuration; and, (c) from the scale height determined from electron or ion distribution with altitude.

The density of the atmosphere is measured (a) with pressure or density gages taking into account the aerodynamic and kinetic effects of the rocket or satellite; (b) from the diffusion rate of released gases; (c) from drag spheres with accelerometers; (d) from the drag of satellites in orbit; (e) from the relative absorption of solar radiation by the atmosphere; and, (f) from the degree of scattering of radiation by the gas. Density is also obtained by comparison of the distribution of the ionic components at altitudes above the E-region and in the exosphere.

Pressure is measured by gages such as the Alphatron, the Bayard-Alpert gage, the ionization gage, the omegatron and mass spectrometers, the Redhead gage, and the diaphragm gage. It is also determined by using the hydrostatic equation and the distribution functions for temperature or density.

Composition of the atmosphere is determined by

(a) various neutral and ion mass spectrometers using magnetic dispersion, with the RF mass spectrometer, and the Massen-filter; (b) optical-spectral studies of the airglow or induced fluorescence; (c) chemical reactions on special surfaces or catalytic agents; and, (d) the use of chemical additions to induce reactions which yield compositional information.

Motions in the atmosphere are studied (a) by tracking spheres, chaff, or other light objects; (b) by measuring the effect on the sound wave front from a grenade explosion; (c) by observing long persistent meteors, trails or tracking the ionization trails of meteors and sporadic ionization using radar methods; (d) by releasing gases at twilight and photographing the gases in fluorescence; (e) from the photometric mapping of airglow and aurora; (f) from the photography of the chemiluminescence of released gases at night; and, (g) by a special configuration of pressure gages on the rocket.

The photochemistry of the atmosphere is studied by means of wide and narrow band photometers and prism or grating spectrometers, and by releasing chemical reagents in the atmosphere.

The interplanetary and atmospheric dust is studied by observing comets and zodiacal light, by observing meteors and by collecting dust using rockets and aircraft. Interplanetary dust is studied from space vehicles by detecting various interactions of dust with surfaces such as the vibration, the light emitted from the impact, the ionization resulting from the impact, the penetration through thin films, the induced magnetic or electrical effects; and measurement of direct damage such as penetration of pressurized cells, breaking wire grids, or strain gauges, and discharging thin film capacitors.

UNDER DEVELOPMENT:

Improved mass spectrometers for determining neutral and ion composition, including the Massenfilter; higher sensitivity RF mass spectrometers; and, lightweight magnetic dispersion mass spectrometers are under development. Likewise, extended range pressure gages to 10^{-13} torr, ruggedized pressure gages, and necessary laboratory calibration facilities are also being developed. Optical instrumentation under development includes ultraviolet spectrometers and photometers for airglow and auroral studies, and light-scattering methods for density and particulate matter distribution. Various reagent gases and condensed materials for use in composition and wind measurements are also being investigated. Microwave radiometers are being developed for the investigation of the atmospheres of Mars and Venus.

S A T E L L I T E S

Project Designation and Contacts	Experimenters	Affiliations	I					
			S	P	A	P	F	P
AIR DENSITY/INJUN EXPLORER (AD-A, AD/I-B, AD/I-C) (Miller/Freeman)								
Determine systematic changes of air density as a function of altitude, latitude, and time of day by drag on a low density sphere. Keating, G.	O'Sullivan, W. Coffee, C.	Langley						
Determine non-systematic changes of the density of the upper atmosphere from studies of the drag on a low density sphere caused by short-term differences in solar activity.	Jacchia, L.	Smithsonian Astrophysical Observatory						

S A T E L L I T E S

Project Designation and Contacts	Experimenters	Affiliations	I					
			A	S	P	R	P	P
<u>ATMOSPHERE EXPLORER (AE-B) (Fellows/Ehrlich)</u>								
Direct measurement of the distribution of the neutral gas species using a double-focusing sector mass spectrometer	Reber, C. Cooley, J.E.	GSFC	X					
Direct measurement of atmospheric density pressure, and temperature using Bayard-Alpert and Redhead ionization gauges	Newton, G. Taeusch, D.R.	GSFC	X					
Measure distribution of electron temperature and density ($10^3/\text{cc}$ to $4 \times 10^6/\text{cc}$) using a swept voltage electron probe	Brace, L.H.	GSFC			X			
<u>BEACON EXPLORERS (BE-A&B) (Opp/Aucremanne)</u>								
Measure distribution of electron temperature and density	Brace, L.H.	GSFC			X			
<u>ORBITING SOLAR OBSERVATORY (OSO-B) (Smith/Halpern)</u>								
Intensity and degree of polarization of zodiacal light at 4750\AA and 8500\AA	Ney, E.P.	U. of Minn.	X					

SATELLITES

III-20

Project Designation and Contacts	Experimenters	Affiliations	I					
			A	P	A	P	P	P
<u>OSO-C (Smith/Halpern)</u>								
Measure spectral intensity of earth-reflected solar radiation (1000Å to 30 microns)	Neel, C.B. Robinson, G.C.	Ames Research Center	✓			X		
<u>OSO-D (Wheel Section) (Smith/Halpern)</u>								
Determine the ratio of sky glow to albedo and the variation of flux from horizon to horizon through the anti-solar point at all hours of local time. Precession of the orbit will survey the latitude dependence.	Mange, P.W. Chubb, T.A. Friedman, H.	NRL				X		
<u>ORBITING GEOPHYSICAL OBSERVATORY (OGO-A&B)</u> <u>(Schardt/Ashworth)</u>								
Lyman-alpha scattering in the geocorona	Mange, P.W.	NRL				X		
Ion mass spectrometry to obtain direct measurements of positive ions (1-50 AMU and from 10 to 10 ⁵ ions/cc)	Taylor, H. Spencer, N.W.	GSFC					X	✓
Micrometeoroids; vector velocity distribution, cumulative mass distribution, effect of geocentric distance	Alexander, W.M. McCracken, C.W.	GSFC					X	

S A T E L L I T E S

III-21

S A T E L L I T E S				I	
Project Designation and Contacts		Experimenters	Affiliations	A	S P R P
OGO-A&B (Contd.)					P F P B
Spherical three-electrode probe to measure densities and energy distributions of charged particles (to 1.0 kev) as functions of position and time	Sagalyn, R.C. Smiddy, M.	AFCRL		✓	X ✓
Planar ion and electron trap to measure densities, temperatures and energy distributions of charged particles of both polarities as functions of position and time	Whipple, E.C. Jr.	GSFC		✓	X ✓
BACKUP EXPERIMENT					
Investigation of the Gegenschein	Wolff, C.L. Hallam, K. Wyatt, S.P.	GSFC U. of Ill.	X	✓	
OGO-C&D (Fellows/Ashworth)					
Use Paul Massenfilter spectrometer tube to obtain neutral and ionic composition of atmosphere (0-6 AMU and 0-40 AMU)	Jones, L.M. Schaefer, E.J.	U. of Mich.		X	✓
Bennett RF ion mass spectrometer for direct measurement of ion composition and density (1-45 AMU)	Taylor, H. Brinton, H.C.	GSFC			X ✓

S A T E L L I T E S

III-22

Project Designation and Contacts	Experimenters	Affiliations	I									
			S	P	A	P	R	P	P	P	P	B
<u>OGO-C&D (Contd.)</u>												
Measure atmospheric density with Bayard-Alpert ionization gauge (10^{-5} to 10^{-10} mmHg)	Newton, G.P.	GSFC										
Measure flux, momentum, and mass of dust particles in the zodiacal light (10^{-13} to 10^{-9} gm)	Alexander, W.M. McCracken, C.W. Berg, O.E. Secretan, L.	GSFC										
Measure electron temperature (800 to 3,000 K) ion or neutral gas temperature (800 to 3,000 K); charged particle density (10^3 to 5×10^6) using a combined retarding potential analyzer	Bourdeau, R.E.	GSFC										
Determine time variation in solar X-ray emission using an ionization chamber (0.5 to 3\AA , $2-8\text{\AA}$, $8-16\text{\AA}$, and $44-60\text{\AA}$)	Kreplin, W. Chubb, T.A. Friedman, H.	NRL										
Monitor the spectral distribution of energy (170 to 1700\AA)	Hinteregger, H.E.	AFCRL										
Photometric airglow measurements (6300\AA , 6200\AA , 5577\AA , 2600\AA , 5890\AA , and 3914\AA)	Blamont, J. Reed, E.	U. of Paris GSFC										
High resolution scan in the UV (between 1100\AA and 3400\AA)	Barth, C.A. Wallace, L.	JPL Yerkes Obsv.										

✓ X

✓ X X

✓ X X

X

X

SATELLITES

I

S P R P

A P A P F P B

Project Designation and Contacts	Experimenters	Affiliations	A	P	A	P	F	P	B
<u>OGO-C&D (Contd.)</u>									
Airglow studies in the Lyman-alpha, far UV (1230Å-1350Å) with UV ion chamber	Mange, P.W. Chubb, T.A. Friedman, H.	NRL					X		
Study origin and fluctuation mechanisms for the trapped radiation belts by measuring trapped and dumped electrons, using Geiger tubes as detectors	Van Allen, J.A. Frank, L.A.	SUI					✓	X	
Study fluctuations in the trapped radiation by measuring low energy trapped radiation and auroral particles (electrons 10-100 kev; protons, 100 kev to 4.5 Mev) using an ion-electron detector	Davis, L.R. Konradi, A. Hoffman, R.A. Williamson, J.M.	GSFC					✓	X	
<u>UNITED KINGDOM SATELLITE (UK-C&D)(Fellows/Halpern)</u>									
Measure distribution of atmospheric ozone at twilight, with filtered photo-cells and spectrometer	Frith, R. Stewart, K.H.	Met. Office, UK Air Ministry						X	
Measure the impact rate, distribution, and effects of micrometeorites	Jennison, R.C.	U. of Manchester England						X	

S A T E L L I T E S

Project Designation and Contacts	Experimenters	Affiliations	I P R P					
			S	P	A	P	F	P B
SAN MARCO (SM-A and B) (Fellows/Ginter)								
Determine the atmospheric density in the equatorial region and the variations from solar heating and other geophysical phenomena		Italian Space Commission						
			X				X	X

S P A C E P R O B E S

Project Designation and Contacts	Experimenters	Affiliations	I					
			S	P	R	P	P	P
			A	P	A	P	F	P
<u>MARINER C & D (Weldon/Reiff)</u>								
Determine the relative abundances of atomic oxygen, atomic hydrogen, and molecular nitrogen in the upper atmosphere of Mars	Barth, C.A. Brandt, J.C. Pearce, J.B. Wallace, L.	JPL Kitt Peak Natl. Obsv. JPL Kitt Peak Natl. Obsv.						
					X			
Obtain TV pictures of Mars using optical telescope with vidicon tube	Leighton, R. Murray, B.C. Sharp, R.P.	CIT						X
					✓			
Measure mass and number of dust particles in space and in the vicinity of Mars	Alexander, W. Berg, O.E. Bohn, J.L. Fuchs, O. McCracken, C.W. Secretan, L.	GSFC GSFC Temple U. Temple U. GSFC GSFC						
							X	✓
<u>PIONEER A & B (Weldon/Reiff)</u>								
Measure momentum, size, direction and distribution of dust particles in interplanetary space	Gault, D.	Ames Research Center						
							X	

OTHER FLIGHT EXPERIMENTS

I					
S	P	R	P		
A	P	A	P	F	P
					B

Project Designation and Contacts

Experimenters	Affiliations
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A P A P F P B

BALLOON (Dubin/Ehrlich)

Investigate the chemical structure, terrestrial accretion rate, and mass distribution of interplanetary material collected at balloon altitudes.

X

SOUNDING ROCKETS

I
S P R P

Project Designation and Contacts	Experimenters	Affiliations	A	P	A	P	F	P	P	B
<u>ARCAS (2 rockets) (Fellows/Holtz)</u>										
Determine correlation with RF radar in-formation of shears and turbulence in the 60 to 90 km region	Gregory, P.	U. of Canter-bury, New Zealand							X	
<u>ARCAS, LOKI II, and HASP (Spreen/Dubin)</u>										
NASA support of Project IRIG. Synoptic measuring program using small rockets (30 to 80 km altitude) to map structure of the atmosphere above balloon altitudes	Tolefson, H.B. Vaughn, W.W. Taiani, A.R. Morrow, H.N.	MSFC								
		Langley							X	(Meteorology)
<u>AEROBEE 150A</u>										
<u>4.67 (D'Aiutolo/Dubin)</u>										
Measure actual micrometeorite pene-tration rates and hypervelocity effects, using large area paraglider detector	Hopko, R.W. Kinard, W.H.	Langley							X	
<u>4.76 (Dubin/Fellows)</u>										
Determine spectrum of the day and night airglow in the UV and effect of latitude, energetic particle excita-tions, atmospheric composition and reaction mechanisms	Fastie, W. Dieke, G.H.	JHU								X

SOUNDING ROCKETS

Project Designation and Contacts	Experimenters	Affiliations	I					
			S	P	A	P	F	P
AEROBEE 150A (Contd.)								
<u>4.83, 4.84 (Dubin/Fellows)</u>	Dunkelman, L. Hennes, J.P.	GSFC			X			
<u>4.85, 4.86 (Moore/Dubin)</u>	Barth, C.A.	JPL						
Determine altitude variation of the dayglow fluorescence spectrum (2000 to 3400Å) and atmospheric composition in the chemosphere					X			
<u>4.99, 4.100, 4.101 (Opp/Holtz)</u>	Hinteregger, H.E.	AFCRL						
Monochromator will record the photon fluxes at a modest number of different fixed wavelengths as continuously as possible						✓	X	
<u>4.113 (Schardt/Dubin)</u>	Berg, O.E. Ailsen, C. Whipple, E.	GSFC						
Determine the altitude distribution, cratering effects, and chemical structure of micrometeorites in the lower ionosphere. Determine the associated ion and electron density distribution and X-ray intensity.								✓

SOUNDING ROCKETS

III-29

<u>Project Designation and Contacts</u>	<u>Experimenters</u>	<u>Affiliations</u>	<u>I</u>	<u>S</u>	<u>P</u>	<u>R</u>	<u>P</u>
			A	P	A	P	P
<u>AEROBEE 300</u>							
<u>6.09-6.12 (Dubin/Holtz)</u>							
Determine altitude profile of atmospheric structure parameters and ionic content and determine function of diurnal-, seasonal-, or latitude-dependence	Brace, L.H.	GSFC					
			X				
<u>ARGO D-4</u>							
<u>8.31, 8.32 (Dubin/Holtz)</u>							
Measure related altitude profiles of ion composition and oxygen and hydrogen airglow for comparison of neutral and ionic species and determination of their distributions	Johnson, C.Y. Hoffman, J. Mange, P.W.	NRL					
			X				
<u>JAVELIN</u>							
<u>8.03 (Dubin)</u>							
Determine composition, density, and energy distribution of the atmosphere to 1,000 km	Sharp, G. McKibben, D.	Lockheed					
							X

SOUNDING ROCKETS

Project Designation and Contacts	Experimenters	Affiliations	A	P	A	P	P	B
<u>JAVELIN (Contd.)</u>								
8.25, 8.26 (Opp/Holtz)								
In conjunction with a separate, simultaneous measurement of solar flux, measure the individual quantities which enter into the continuity equation. Some cross-checking with topside sounder data is also planned	Bordeau, R.E. Spencer, N.W. Bauer, S.J. Taylor, H.A.	GSFC						
								X
<u>NIKE-CAJUN</u>								
10.54-10.55; 10.61; 10.62, 10.63, 10.71, 10.73, 10.74, 10.86-10.89 (Spreen/Dubin)								
Measure wind and temperature profiles between 30 and 95 km to investigate seasonal, geographical, and diurnal patterns and their causes	Nordberg, W. Smith, W.	GSFC						
								X
<u>4 rockets to be assigned (Hipsher/Fellows)</u>								
Study chemiluminescent reaction efficiencies and determine atmospheric motion during darkness	Hord, R.	Langley						X

(Meteorology)

SOUNDING ROCKETS

III-31

S O U N D I N G R O C K E T S				I
Project Designation and Contacts	Experimenters	Affiliations	A	P
<u>NIKE-CAJUN or other rockets</u>				
<u>(12 to 30 rockets) (Dubin/Spreen)</u>				
Systematic measurements of atmospheric structure and its variations with time of day and season from 110 km and below, using sphere drag	Jones, L.M. Peterson, L.	U. of Mich.	X	
		(Meteorology)	X	
<u>NIKE-APACHE</u>				
<u>14.10, 14.11 (Dubin/Horowitz)</u>				
Determination of the chemical and ionic composition of the atmosphere and the generation and loss mechanisms of atmospheric constituents. Measurements of atmospheric structure variations as affected by solar radiation and particle bombardment	Schaefer, E. Jones, L. M.	U. of Mich.	X	/
<u>14.22 through 14.25 (Dubin/Horowitz)</u>				
Investigate atmospheric structure parameters (pressure, temperature, density and winds) especially for diurnal dependence above 100 km	Horvath, J.	U. of Mich.		X

SOUNDING ROCKETS

Project Designation and Contacts	Experimenters	Affiliations	I					
			S	P	R	P	A	P
			A	P	A	P	F	P
							B	B
<u>NIKE-APACHE (Contd.)</u>								
<u>14.102, 14.103 (Hipsher)</u>								
Determine reaction rates, intensity of solar induced resonance radiation and persistency of chemical clouds	Potter, A.E.	Lewis						
							X	
<u>14.128-14.131 (Dubin/Holtz)</u>								
Investigate the tidal and dynamo motions and current systems between 80 and 200 km altitude	Sarabhai, V.	Indian Natl. Cmte. for Space Res.						
							X	✓
<u>14.150 - 14.154 (Freeman/Holtz)</u>								
Studies of energetic auroral electrons and protons	O'Brien, B.J.	Rice U.					✓	X

S U P P O R T I N G R E S E A R C H

Project Designation and Contacts	Investigators	Affiliations	I					
			S	P	R	P	A	P
R-18 (Moore) Support of U of Hawaii-U of Colorado re- search on zodiacal light and airglow (icw NSG-135)	Roach, F.E.	NBS, CRPL	X				✓	
R-64 (Hipsher/Fellows) Studies of the vacuum UV spectra of atoms and small molecules containing elements such as hydrogen, carbon, nitrogen, and oxygen	Bass, A.M.	NBS, DC					X	
NASr-7 (Alexander/Dubin) An analytical and limited experimental study of the mechanisms of impact, penetra- tion, and light emission for micromete- orites on an aluminum-coated photomultiplier	Todd, F.C.	Okla. St. U.					X	
NASr-49 (07) (Gilbert/Fellows) Theoretical research on low energy electronic, ionic and atomic impact phenomena	Smith, F.T.	SRI					X	
NASr-54 (05) (Dubin/Horowitz) Using a Paul Massenfilter mass spectrometer measure the properties of the upper atmos- phere and conduct flight tests to obtain atmospheric composition data	Jones, L.M.	U. of Mich.					X	✓

S U P P O R T I N G R E S E A R C H

III-34

Project Designation and Contacts	Investigators	Affiliations	I					
			S	P	R	P	A	P
NASr-65 (01) (Easter/Gaugler) Radiative energy transfer on entry into Mars and Venus	Davies, W.O.	Armour Res. Foundation		X				
NASr-82 (Moore) Construction of a 60-inch lunar and planetary telescope	Kuiper, G.P.	U. of Ariz.		✓				X
NASr-158 (D'Aiutolo/Keller/Dubin) Investigations of the properties, flux and trajectories of meteors	Whipple, F.L.	Harvard College Obsv.		X				
NASr-185 (Gaugler) Studies of planetary atmosphere and lunar photography (Balloon flights)	Roberts, W.O.	UCAR		X				✓
NASw-513 (Easter/Gaugler) Design studies for instrumenting an experiment to sound the Venus ionosphere from the topside	Sperber, A.O. Flattau, T. Knecht, R.W.	AIL CRPL					✓	X
NASw-561 (Berg/Dubin) Investigation of the physics of hypervelocity impacts and meteor simulation using the 2 Mev acceleration	Langmuir, D.B.	STL						X

S U P P O R T I N G R E S E A R C H

Project Designation and Contacts	Investigators	Affiliations	I					
			S	P	A	P	P	B
NASw-589 (Donn/Fellows) Research studies and investigations directed toward attaining the reproduction of the spectra obtained from observations of natural comets	DeCarlo, V.J.	Melpar						
NASw-701 (Fellows/Dubin) Laboratory and theoretical studies in the vacuum ultraviolet	Marmo, F.F.	GCA	X					
NASw-704 (Easter/Gaugler) Determination of average surface temperature of Mars from radiative equilibrium considerations. Venus investigations will be devoted primarily to an evaluation of available information and analysis of existing models of the atmosphere	Ohring, G.	GCA						
NASw-705 (Horowitz/Fellows) Study of the physical processes occurring at the lowest pressures attainable in the laboratory	Kreisman, W.S.	GCA	X					✓
NASw-707 (Donn/Fellows) Research to obtain an improved understanding of the chemical composition of comets	Friel, D.D.	DuPont de Nemours & Co.	X					
NASw-790 (Easter/Barth) Continue development of millimeter wave scanning spectrometer	Wertman, R.C. Blanchard, R.J. Wilmarth, R.W.	IT&T						X

S U P P O R T I N G R E S E A R C H

Project Designation and Contacts	Investigators	Affiliations	I									
			A	P	S	P	A	P	P	P	P	B
NsG-58 (Dubin/Moore) Detailed theoretical studies of inter-planetary dust and gas utilizing available data and newly-acquired information from direct space probe measurements	Singer, S.F. Opik, E.J.	U. of Md.			X							
NsG-69 (Roman/Ott) Design and construct television system for use with telescopes above the earth's atmosphere.	Schwarzschild, M.	Princeton U.	X								✓	✓
NsG-118 (Easter) Theoretical study of the dynamics of the upper atmosphere	Hines, C.	U. of Chicago						X	✓			
NsG-135 (Moore) Study on zodiacal light selected lines in the airglow spectrum (icw R-18)	Steiger, W.R.	U. of Hawaii	X					✓				
NsG-158 (Fellows/Hipsher) Research in fundamental atom chemistry with application to the chemistry of the upper atmosphere	Harteck, P.	RPI								X		
NsG-178 (Easter) Basic research concerning the interaction in vacuum of photons in the UV region (100-1000A) with solids	Weissler, G.L.	U. of S. Calif.						X				
NsG-192 (Easter/Allenby) Conduct research on methods of improving the sensitivity and reliability of gas chromatographs	Lipsky, S.R.	Yale U.										
								X			X	X

S U P P O R T I N G R E S E A R C H

Project Designation and Contacts	Investigators	Affiliations	I					
			S	P	A	P	P	B
NsG-199 (Easter/Gaugler) Improve the sensitivity and reliability of the detection device involving the principle of gas chromatography	Lovelock, J.E.	U. of Houston	✓				X	
NsG-217 (Fellows) Photochemistry in the far UV	Taylor, H.A.	NYU	X					
NsG-219 (Dubin/D'Aiutolo) Radar studies of southern hemisphere meteors are to be made using a single transmitter at 69.5 Mc/sec and a system of three receivers	Ellyett, C.	U. of Canterbury, New Zealand	X					
NsG-224 (Moore) Study of polarization of the decametre wave radiation from Jupiter	Barrow, C.H.	Fla. St. U.	X	✓				
NsG-258 (Easter/Gaugler) Develop a submillimeter interference spectrometer	Rivers, W.K. Jr.	Ga. Inst. of Tech.	X					
NsG-261 (Easter/Gaugler) Laboratory investigations of the composition and chemical behavior of the Venus atmospheres	Harteck, P.	RPI	X					

S U P P O R T I N G R E S E A R C H

III-38

Project Designation and Contacts	Investigators	Affiliations	I							
			S	P	A	R	P	P	F	B
NsG-263 (Fellows) Quantum mechanical calculations and studies on atomic systems of astro-physical interest	Matsen, F.A.	U. of Texas	✓	X						
NsG-269 (Holloway/Holmes) Fundamental research in earth and planetary sciences	Berkner, L.V. GRCSW			X						
NsG-275 (Harrison/Holloway/Liddell/Fellows) Research in theoretical chemistry, particularly in molecular quantum and statistical mechanics	Hirschfelder, J.O. U. of Wisc.		✓							
NsG-286 (Easter/Horowitz) Experimental research on mass spectrometer techniques for the study of planetary atmospheres	Nier, A. U. of Minn.			X						
NsG-291 (Dubin/Moore) Systematic in-flight photography and subsequent recovery of meteorites	Whipple, F.L. SAO			X				✓	X	
NsG-304 (Fellows/Hipsher) Laboratory and theoretical studies in the application of chemical release techniques to investigations of the upper atmosphere	Edwards, H.D. Ga. Inst. of Tech.			X						

S U P P O R T I N G R E S E A R C H

Project Designation and Contacts	Investigators	Affiliations	I R P					
			S	P	A	P	F	P
NsG-329 (Easter) Radio propagation techniques for the study of planetary ionospheres and interplanetary medium	Garriott, O.K.	Stanford U.	✓	x				✓
NsG-337 (Fellows/Hipsher) Research on chemical reactivity of hydro- gen, nitrogen, and oxygen atoms at tempera- tures below 100° K	McGee, H.A. Jr.	Ga. Inst. of Tech.		x				
NsG-349 (Fellows) Laboratory spectroscopy research program	Nicholls, R.W.	U. of W. Ontario	x					
NsG-362 (Moore) Obtain transmission spectra of the sun through simulated atmospheres, comparison spectra of the planets, and reflection spectra of the sun from laboratory simulated polar cap crystals	Heyden, F.J.	Georgetown Univ. Obsv.			x			✓
NsG-376 (Horowitz/Fellows) Theoretical and experimental studies of the underlying processes and techniques of low pressure measurement	Alpert, D.	U. of Ill.		x				
NsG-377 (Easter) Program of lunar and planetary research with radio and radar astronomy techniques	Eshelman, V.R.	Stanford U.	✓	x				x

S U P P O R T I N G R E S E A R C H

<u>S U P P O R T I N G R E S E A R C H</u>		
<u>Project Designation and Contacts</u>	<u>Investigators</u>	
NsG-419 (Moore/Fellows) Electromagnetic investigation of planetary atmospheres	Barrett, A.H. Graham, J.W. Rafuse, R.P.	
NsG-458 (Easter/Gaugler) Development of chemisorption detectors	Hoenig, S.A.	

SUPPORTING RESEARCH AT NASA CENTERS

TASKS	TECHNICAL MONITORS	I S P R P A P A P F P B											
		A	P	A	P	P	F	P	B				
Ames Research Center													
Determine absorption coefficients and line profiles for gases of interest in planetary atmospheres employing a gas cell (with multiple reflection optics) to achieve optical path lengths up to 1 km. Determine broadening due to temperatures ranging from 77°K to 600°K and due to pressures from 10 ⁻⁴ mm Hg to 10 atmospheres.	Miller, J. Boese, R.												
Study the possible use of motion and heating data from capsules entering planetary atmospheres in the determination of the atmospheric structure and gas properties of those atmospheres.	Seiff, A.												
Study the chemical physics of formation of chemical complexes, free radicals, and their molecular constitution in interplanetary space, on comets and on the planets as they are influenced by solar radiation, energetic particles, fields, elemental abundances and other environmental parameters.	Papazian, H.												
Conduct theoretical studies of models for planetary atmospheres to determine chemical composition, structure, atomic processes and dynamical behavior.	Spreiter, J.R.												

III-42

TASKS	TECHNICAL MONITORS	A	P	S	I
			P	R	P
			F	P	B
Ames Research Center (Contd.)	Augason, G.	X	✓		
Extended determination and detailed description of stellar and planetary experiments which can be performed from an infrared OAO, from sounding rockets and from ground-based observatories. Theoretical studies of processes in stellar atmospheres as they may influence IR emission and absorption with particular emphasis on proto stars, red giant stars, and late stars on the main sequence.					
Goddard Space Flight Center	Miller, J.	X	✓		
Obtain IR emission spectra and f-values and damping constants of atoms and molecules of astrophysical interest employing controlled plasma sources, extending determinations and line or band assignments out to 15 microns. Atomic species of interest include N, O, C, H, He and others. Molecular species of interest include CH, OH, NH, CO, CN, C ₂ , H ₂ , O ₂ , as well as metallic hydrides and oxides.					
Goddard Space Flight Center	Spencer, N.W.				✓
Develop analytical methods to obtain a better understanding of planetary atmospheres and devise concepts for simple experiments and probes which can be flown into these atmospheres. Development of sensors includes pressure gages, temperature gages, gas composition measurement devices, diaphragm gages, mass spectrometers, and optical devices.					

SUPPORTING RESEARCH AT NASA CENTERS

III-43

TASKS	TECHNICAL MONITORS	I							
		A	P	A	P	R	P	F	P
Goddard Space Flight Center (Contd.)									
Research involving integrating equations describing the dynamical behavior and composition of atmospheres.	Hess, W.N.			X					
Fabrication of improved components and techniques associated with ultra-low current detectors used with aeronomy direct measurement sensors.	Spencer, N.			X					
Development of improved calibration systems and experimental techniques for advancing the interpretation of the performance of pressure gages and spectrometers.	Spencer, N.			X					
Development and evaluation of advanced designs of thermionic and cold cathode pressure gages and RF spectrometers which are planned for future satellite and probe applications.	Spencer, N.			X					
Extend the understanding of the physical processes involved in the performance of the RF spectrometer tube and to develop improved techniques in interpreting ion composition measurements; including theoretical and laboratory investigations intended to verify existing theories and to explore new areas.	Spencer, N.			X					

SUPPORTING RESEARCH AT NASA CENTERS

III-44

TASKS	TECHNICAL MONITORS	I									
		A	P	S	P	R	P	P	F	P	B
Goddard Space Flight Center (Contd.)											
Design and development of experiments with subsequent development and testing of sensors for measuring the various parameters necessary to describe the nature and origin of interplanetary dust.	Alexander, W.M.		X								
Obtain a clearer insight of lunar and planetary surfaces and the composition of extraterrestrial material by studying the mechanism by which grooves and pits are formed on tektites, the study of micrometeorites from Antarctic ice and the study of lunar impactites if such impactites can be recovered.	O'Keefe, J.A.										
Extend, by experimental and theoretical studies, the theory of crystal growth under astronomical conditions are related to interstellar and interplanetary grains. This will be followed by a laboratory study of the processes involved when condensed volatile matter is exposed to UV light and corpuscular radiation.	Donn, B.D.		X								
Ground-based evaluation and test of instrumentation and antenna concepts for space radio astronomy; synoptic monitoring of solar and Jupiter radio emission.	Stone, R.	X	✓								
Research on low energy scattering of electrons by atomic and molecular systems.	Levine, A.	✓									
Perform theoretical studies on three body collisions.	Hess, W.N.		✓								

SUPPORTING RESEARCH AT NASA CENTERS

TASKS	TECHNICAL MONITORS	I							
		A	P	A	P	F	P	B	
Jet Propulsion Laboratory									
Develop an interferometer spectrometer of rapid scan capability (20 sec) which is suitable for Mars 66-69 mission.	LaPorte, D.D.	X					✓		
Develop gas chromatograph technology in the direction of low-volume, lightweight instrumentation suitable for Voyager planetary entry capsules. Investigations will be directed toward both atmospheric and organic systems.	Josias, C.			X			X		
Conduct spectroscopic investigation of the UV spectrum of atmospheric gases with a variety of instruments and techniques.	Mackin, R.J. Jr.			X					
Design, construct, test and evaluate a scientific breadboard model of a fixed grating, multiple detector IR spectrometer. Demonstrate feasibility of using this instrument for making temperature soundings in atmospheres and determining the existence of biology on planet surfaces from emission spectra.	Thiele, C.							X X	X X

SUPPORTING RESEARCH AT NASA CENTERS

TASKS	TECHNICAL MONITORS	I					
		A	P	A	P	F	P B
Jet Propulsion Laboratory (Contd.)							
Develop the necessary techniques to calibrate spectrometric flight instruments for use in the vacuum UV portion of the spectrum. The development of UV sources, calibrated detectors and an improved vacuum chamber are initial tasks.	Thiele, C.	✓	✓	X			
In measuring the nightglow in the earth's atmosphere, extremely small quantities of radiated energy must be measured, stored, and displayed. This research includes the investigation of sensors, circuits appropriate to blue sensors and data display techniques.	Thiele, C.						
The phenomena that are being studied in the laboratory include those important in the night airglow, the twilight glow, the dayglow, the aurora, and upper atmosphere atomic and ionic reactions. Theoretical calculations are performed with the aim of predicting spectral features of the atmosphere using cross-sections and reaction rates determined in laboratory experiments.	Mackin, R.J. Jr.			X			
Quantitative spectra of long paths of CO ₂ , N ₂ , CH ₄ , NH ₃ , will be obtained in high and low resolution and at varying pressure and temperature using a 20', high temperature, high pressure White Cell. Also, there will be the calculation of model atmospheres, and the determination of their heat balance and hydrodynamics.	Gray, F.B.				X	X	
							X

SUPPORTING RESEARCH AT NASA CENTERS

TASKS	TECHNICAL MONITORS	I									
		A	P	A	P	F	P	B			
Jet Propulsion Laboratory (Contd.)											
Develop a flight mass spectrometer that will be capable of measuring the composition at the extremely low pressures found in the lunar atmosphere, solar wind, deep space, and possibly comet tails.	Gray, F.B.			X			✓	✓			
Develop a flight package mass spectrometer for planetary atmosphere analysis. The target weight and power maximums are to be five pounds and five watts.	Gray, F.B.			X							
Build and fly instruments to measure N ₂ , CO ₂ , A, and O ₃ in the atmospheres of Mars and Venus.	Gray, F.B.			X							
Perform design studies and initiate the engineering design of a multi-pass absorption tube which is to be used in the study of absorption phenomena in planetary atmospheres. Various gases which are expected to be found in the atmospheres of planets must be confined at high pressures and temperatures under conditions of extreme purity.	Thiele, C.			X							
Investigate new techniques in gas chromatography technology. These investigations will be focused on the following areas: study of new column designs, study of new detectors, study of sample handling techniques, and advanced chromatograph systems.	Thiele, C.			X							

SUPPORTING RESEARCH AT NASA CENTERS

TASKS	TECHNICAL MONITORS	I											
		A	S	P	A	P	R	P	F	P	F	P	B
Jet Propulsion Laboratory (Contd.)													
Investigate the physical processes occurring in planetary atmospheres by measurement of intensity and line widths of millimeter wave emission from and through these atmospheres. Determine planet surface characteristics by means of emissivity mapping techniques.	Gray, F.B.	X			✓								
Extend our knowledge of the moon and the planets through ground-based observation and measurements. Determine the compositions, thermal structures and velocity fields in planetary atmospheres, and acquire knowledge on the characteristics of the lunar surface, using Coude focus spectrometers.	Gray, F.B.												
		X			✓					✓			
Marshall Space Flight Center													
Study of physical chemical reactions of interest in the upper atmosphere with special emphasis on the behavior of water under intense solar radiation.	Frary, S.G.												
					X								

IONOSPHERES AND RADIO PHYSICSOBJECTIVES:

The earth's ionosphere is that part of the upper atmosphere which is sufficiently ionized to affect radio waves. Similar ionized regions are expected, to a greater or lesser degree, around the moon and planets, and in interplanetary space. The NASA program in Ionospheres and Radio Physics is concerned with investigating the nature, origin and behavior of these ionized regions, as well as their influence on radio waves. To date, primary emphasis has been placed on the terrestrial ionosphere, in addition some plasma measurements have been made from interplanetary probes.

The earth's ionosphere is produced by the interaction of solar radiations and energetic particles with the neutral atmosphere. Much progress has been made in establishing the density, temperature and neutral composition of the atmosphere. Progress has also been made in measuring the flux of the ionizing radiations. Although these measurements are not sponsored by the ionospheric and radio physics discipline, they are essential to the interpretation of ionospheric data. For easier reference, the ionosphere has been divided into three regions. In the D region, 50-85km, the ion density is low and the collision frequency is high. The E region, 85-140 km, defines a transition zone in which the ionization rises rapidly with altitude and the collision frequency is still high enough to cause radio-absorption. The highest electron densities occur in the F region at an altitude of about 300 km. The collision frequencies are too low to cause much absorption and the major effects on radio-propagation are caused by the high refractive index.

D-REGION

The D-region is the lowest ionospheric subdivision where a significant number of free electrons are found.

The investigation of the D-region is difficult because of the low charged particle concentrations, the relatively high gas density resulting in high electron collision frequencies, and because of the high probability of negative ion formation. Since the D-region lies below the minimum satellite altitude, direct measurements are made with sounding rockets.

Radiation observations made during quiet solar conditions show that the three most probable ionizing agents are cosmic rays, Lyman- α (1215.7 Å) and X-radiation (2-8 Å). It appears that the lowest part of the D-region ionization is produced by cosmic rays, the intermediate part by Lyman-ionizing the trace constituent NO, and the upper part (merging into the E layer) by X-rays and Lyman- β .

Studies made of the lower D-region during disturbed solar conditions on the sunlit side of the earth show that it is possible to ascribe the increased ionization to abnormally high X-ray fluxes, which have been observed from rockets at low D-region altitudes. The influx of energetic protons and electrons at auroral latitude during solar flares produces enhanced ionization unique to this latitude region. By means of rockets fired into the disturbed polar D-region and by using particle counters in satellites, it has been shown that increases in the electron content of the D-region at high latitudes are often directly related to the "dumping" of particles trapped in the earth's magnetic field.

Further theoretical and experimental investigations are necessary to firmly identify the D-region ionizing agents and their interactions with the neutral atmosphere. Polar Cap Absorption events are as yet poorly understood and need further exploration. Particular emphasis will be placed on simultaneous measurements of radio wave absorption, electron and ion densities, and auroral particle influxes. Attempts should also be made to more definitely correlate D-region phenomena with solar conditions. NASA is currently planning or already funding approximately 20 sounding rocket launches

to investigate these phenomena in the D and low E-region. In addition the Polar Orbiting Geophysical Observatories, the Air Density/Injun Explorers and the Atmosphere Explorers will carry experiments relevant to these problems.

E-REGION

The E-region has been studied intensively both from ground based instruments and from sounding rockets. Until recently, however, there had been no detailed observations of the nighttime E-region. These observations revealed the existence at about 120 km of a very pronounced "valley" in the nighttime ionization distribution. This phenomenon will be investigated further to attempt to establish its cause and morphology.

Important advances have been made in our knowledge of sporadic E ionization. Several different groups using rocket-borne instruments have observed thin layers of increased electron concentration, one or two kilometers thick. It has also been shown, by observing luminous clouds of sodium ejected from rockets, that marked wind shear often occurs at the same general time and altitude as a sporadic E layer. The wind shear in the presence of the geomagnetic field may be the cause of the sporadic E layer. Experimental and theoretical investigations of sporadic E will be continued. The phenomenon of sporadic E will be studied with additional sodium releases and rocket borne probes during the coming year. In addition the plasma resonance probe is being developed for rocket flight to explore the E-region "valley".

F-REGION

The most phenomenal advances in ionospheric physics have been made in the exploration of the region above the peak of electron density at about 300 km. This was made possible by means of a satellite mounted ionosonde (Topside Sounder), the development of the high powered incoherent backscatter radar, and the direct measurement of electron

concentration and ion masses with probes carried in rockets and artificial satellites.

Perhaps the most important result derived from this program is the discovery of ionized helium in the upper atmosphere. It was formerly generally supposed that the atmosphere at heights greater than about 300 km consisted of oxygen at the lower altitudes and hydrogen at the higher altitudes. Air density studies from satellites indicated that helium probably was an important constituent. This was later verified by mass spectrometer measurements from rockets and satellites.

Many unknowns still exist in our knowledge of the topside of the ionosphere. More knowledge is required on the temperature of the electrons, ions and neutral constituents. Gaps exist in our knowledge of the densities and composition of the neutral constituents above the F2 maximum. The morphology of the recently discovered ionized helium layer is very poorly known and will be explored in more detail. The phenomenon of field aligned ionization (equatorial anomaly) requires additional experimental and theoretical investigation, as well as the polar F-region which involves the interrelation between ionospheric phenomena, auroral phenomena, and charged particle trapping and dumping.

These problems are all being pursued by a series of sounding rockets and artificial earth satellites. Approximately ten sounding rocket flights are planned into the F-region. The joint US/UK topside sounder, ALOUETTE, is still functioning perfectly, gathering data between the F2 maximum and approximately 1000 km. The Beacon Explorers (BE-A,B) and the Ionosphere Explorers (IE-A,B) will both measure ionospheric parameters. The measurements begun by the topside sounder ALOUETTE I and the direct measurement ionospheric satellite, EXPLORER VIII, are being incorporated into a series of international satellites called the International Satellites for Ionospheric Study (ISIS) which will continue the topside measurements throughout a

complete solar cycle. The Polar Orbiting Geophysical Observatories, the Eccentric Geophysical Observatories and the Energetic Particle Explorer will continue study of the influxes and energies of particles impinging on the atmosphere. The Atmospheric Structure Satellite will contribute information on the composition, density, pressure, and temperature of the upper atmosphere between about 250 and 1100 km.

EXOSPHERE-INTERPLANETARY SPACE

The region above the F2 maximum gradually decreases in density and electron content to interplanetary space, where a density of 100 to 1000 particles/cm³ or less is reached. This area is important to an understanding of the lower ionosphere because many of the physical processes occurring in the upper reaches of the atmosphere directly contribute to the constitution and ion-electron concentrations of the F-region. The necessity of maintaining communications contact with deep space probes and manned spacecraft make it mandatory that the physics of radio propagation through this region are more fully understood. This region can be studied indirectly by observing the propagation of very low frequency radio waves. VLF emissions propagate along the field lines of the geomagnetic field, allowing one to investigate properties of the upper atmosphere out to the magnetospheric boundary.

The Interplanetary Monitoring Platform (IMP) Program will furnish a great deal of information on the particle fluxes impinging on the ionosphere. Experiments carried aboard the first IMP (launched in November 1963) will measure various energy ranges of cosmic rays, several parameters of the solar wind and magnetospheric interaction with the solar wind. An advanced concept of the IMP is to anchor the spacecraft to an interplanetary object, the moon, allowing the satellite to go around the earth once every 28 days and at the same time maintain an essentially constant distance from the earth. Observations of radio-transmission through interplanetary space and of any perturbations produced by

an object like the moon could be made from such a spacecraft. Observations of the interplanetary media will be made from the space-probe "PIONEER". By studying radio-transmission of several phase coherent signals at different frequencies from PIONEER together with directly measured parameters, information can be obtained on the constitution and dynamics of the interplanetary medium.

TECHNIQUES AND INSTRUMENTS:

AVAILABLE:

The propagation of radio waves from the ground to the ionosphere and back is the oldest technique for ionospheric research. Sweep frequency soundings at vertical incidence provide useful propagation data, and enable electron density profiles to be obtained from the bottom of the E region to the peak of the F region. This determination is unambiguous when the profiles are monotonic, but there are ambiguities and difficulties in interpretation when valleys are present. Many sites are now available for synoptic studies, but some gaps exist in coverage, so that additional stations may be needed to support specific experiments. Variations of this technique, such as phase path measurements, intermodulation measurements and partial reflection measurements have been used on a much smaller scale, and are particularly useful for D and E-regions. Observations at very low frequencies of whistlers, generated by lightning flashes, and VLF transmitters provide integrated measurements approximately along magnetic field lines. These are particularly important for studying the magnetosphere.

Passive observations by ground-based receivers (riometers) provide data on irregularities and D-region absorption when receiving stellar and galactic sources. By using high gain antennas, synchrotron emission has also been observed from the radiation belts.

Another available technique utilizes the one-way propagation of radio signals from rockets or satellites. The

rocket experiments are particularly suitable for unambiguous determinations of electron density and collision frequency with high resolution in an undisturbed ionosphere, but must be interpreted with increasing care as the vehicle reaches higher altitudes. Satellite observations yield primarily the electron content between vehicle and observer, and also provide some information on irregularities.

Direct sampling of the ionosphere from space vehicles is another technique. Such experiments rely on radio telemetry of the data back to the ground, rather than on physical recovery of the data or of samples. Such techniques permit the measurement of those ionospheric variables which are so essential to an understanding of the fundamental ionospheric parameters. They are particularly useful in the study of anomalous or rapidly changing ionospheric conditions which disrupt communications, because propagation measurements are considerably more difficult to perform and to interpret quantitatively under such circumstances. The direct sampling techniques now in use include:

<u>Instrument</u>	<u>Primary Parameter</u>
a. Radio frequency impedance probe	Electron density
b. Langmuir probe	Electron thermal velocity distribution, electron density
c. Ion trap	Ion density
d. Ion spectrometer	Ion mass distribution
e. Gerdien condenser	D-region ionization

The topside sounder is an obvious extension of the ground based ionospheric sounder which can be used to make observations above the F2 peak. The topside sounder consists of three main elements: transmitter, antenna, and receiver.

The display system is on the ground and connected to the ionosonde by the telemetry system. Because of lower noise and interference levels, the topside sounder transmitter radiates a few watts of pulse power, in contrast to several kilowatts for a ground based ionosonde. The topside receiver is similar to a ground based ionosonde except that a very wide dynamic range and automatic gain control are necessary. Long antennas of the order of 10 to 50 meters are required for ionosondes of 1 to 12 Mc/s. Techniques for the interpretation of topside sounder ionograms are being developed analogous to the techniques for ground based ionosondes.

A two frequency propagation experiment for use in small (15 cm diameter) sounding rockets has been developed. The choice of relatively high frequencies (24.5 and 73.6 Mc/s) permits the use of a very simple rocket antenna configuration. The propagation experiment occupies about half the payload space of a Nike-Cajun rocket, leaving the remaining space for one or two secondary experiments. The self-sufficient nature and relatively low cost of this payload makes it well suited for general use by the international scientific community.

The ground based incoherent backscatter radar is a technique for making ionospheric measurements above the F2 peak. The technique obtains information on the ionosphere above the F2 peak by measuring the power spectrum and Faraday rotation of incoherent radar signals scattered from free electrons. To date, the technique has produced information on electron densities and the ratio of electron to ion temperature above the F2 peak.

A basic problem inherent in making direct measurements from a spacecraft is the presence of the plasma sheath around the craft. The technique of exciting plasma resonances promises to overcome this difficulty. Plasma resonance occurs at the electron gyrofrequency and its harmonics, and at frequencies where the phase refractive index is infinite or zero at the satellite. Since it is a radio propagation

technique, a larger space around the satellite is sampled and the effect of the plasma sheath should be less significant than with electron traps. The concept is currently being developed as a method for exploring the E-region "valley" from sounding rockets and may have a more general application.

The radio occultation method is a technique which promises to be very effective in the study of the possible ionospheres of the moon and other planets. In this experiment, a radio beacon is mounted in a space probe. As the spacecraft passes behind the moon or a planet, the radio transmissions from the beacon are occulted. By carefully observing the radio occultation, information can be obtained on the presence and nature of lunar or planetary ionospheres. This method was developed from the technique of radio star occultation; but is an advance over radio star occultation in that the physical characteristics (frequency, polarization, signal strength, etc.) of the source are exactly known and phase-coherent signals having different frequencies can be observed simultaneously. In another method a powerful transmitter bounces signals off the moon or planets; the direct signal and the echo are then received on the spacecraft. This will permit a more detailed exploration of the planetary surface than is feasible by ground observations of the echo.

S A T E L L I T E S

Project Designation and Contacts	Experimenters	Affiliations	I					
			S	P	R	P	A	P
<u>ATMOSPHERE EXPLORER (AE-B) (Horowitz/Ehrlich)</u>								
Measure distribution of electron temperature and density ($10^3/\text{cc}$ to $4 \times 10^6/\text{cc}$) using a swept voltage electron probe	Brace, L.	GSFC						
Direct measurement of the distribution of the neutral gas species using a double-focusing sector mass spectrometer	Reber, C. Cooley, J.E.	GSFC						
Direct measurement of atmospheric density, Newton, G. pressure, and temperature using Bayard-Alpert and Redhead ionization gauges	Taesch, D.R.	GSFC						
<u>IONOSPHERE EXPLORER (IE-A&B) (Opp/Aucremanne)</u>								
Measure electron density height profile by pulse delay (300 to 1,000 km) and measure cosmic noise level (2 to 7 Mc)	Knecht, R.W.	NBS (CRPL)						
ARIEL ion mass probe will determine relative ion mass concentrations, absolute ion densities, and ion temperature	Boyd, R.L.F. Willmore, A.P.	Univ. College, London						

S A T E L L I T E S

Project Designation and Contacts	Experimenters	Affiliations	A	S	P	R	P	I
BEACON EXPLORER (BE-A&B) (Opp/Aucremanne)								
Ground-based measurements of Faraday rotation, Doppler, and scintillations, using multifrequency beacon		U. of Ill. Penn St. U. Stanford U. NBS, CRPL International participants						
Measure distribution of electron temperature and density	Brace, L.H.	GSFC		✓				X
INTERPLANETARY EXPLORER (IMP-A,B&C) (Freeman/Ehrlich)								
Planar trap ion-electron detector for plasma measurements in thermal energy range (0 - 10 ev)	Serbu, G.P. Bourdeau, R.	GSFC		✓				X
ORBITING SOLAR OBSERVATORY (OSO-D) (Wheel Section) (Smith/Halpern)								
Solar radiation monitoring (8 to 16Å, 2 to 8Å, 0.5 to 3Å, and 0.1 to 1.6Å)	Chubb, T.A. Kreplin, R.W. Friedman, H.	NRL		X				✓

SATELLITES

Project Designation and Contacts	Experimenters	Affiliations	A	S	P	R	P	I
<u>OSO-E (Wheel Section) (Smith/Halpern)</u>								
This experiment will provide absolute indices of solar activity by routine X-ray measurements using sets of standardized X-ray ion chamber photometers.	Chubb, T.A. Kreplin, R.W. Friedman, H.	NRL	X					✓
<u>ORBITING GEOPHYSICAL OBSERVATORY (OGO-A&B)</u> <u>(Schardt/Ashworth)</u>								
Spherical three-electrode probe to measure densities and energy distributions of charged particles (to 1.0 kev) as functions of position and time	Sagalyn, R.C. Smiddy, M.	AFCRL			✓	X		✓
Planar ion and electron trap to measure densities, temperatures and energy distributions of charged particles of both polarities as functions of position and time	Whipple, E.C. Jr.	GSFC			✓	X		✓
Mapping VLF noise and propagation (0.2 to 100 kc/s) as function of time, location, and frequency	Helliwell, R.A. Rorden, L.H.	Stanford U. SRI						X

S A T E L L I T E S

I

S P R P
A P A P F P B

Project Designation and Contacts

Experimenters

Affiliations

OGO-A&B (Contd.)

Radio beacon to radiate linearly polarized signals (40 to 360 Mc) toward the earth to measure electron content and scintillations as functions of position & time

Chivers, H.J.A.
Lawrence, R.S.

NBS, CRPL

X

Curved plate spectrometer used as plasma probe to measure proton concentrations (10^{-2} to 10^{-4} particles/cm³) as a function of proton energy (0.2 to 20 kev)

Wolfe, J.

Ames Research
Center

/ X

Proton and electron Faraday cup plasma probes to measure proton flux and energy spectrum, and their variations (10 ev to 10 kev)

Bridge, H.
Bonetti, A.
Rossi, B.
Lažarus, A.J.
Scherb, F.

MIT

/ X

Ion mass spectrometry to obtain direct measurements of positive ions (1-50 AMU and from 10 to 10^5 ions/cc)

Taylor, H.
Spencer, N.W.

GSFC

X /

Measure cosmic noise at two fixed frequencies in the 2 to 4 Mc/s range

Haddock, F.T.

U. of Mich.

/

X /

SATELLITES

Project Designation and Contacts	Experimenters	Affiliations	I					
			S	P	A	P	F	P
<u>OGO-C&D (Fellows/Ashworth)</u>								
Measure electron temperature (800 to 3,000 K) ion or neutral gas temperature (800 to 3,000 K); charged particle density (10^3 to 5×10^6) using a combined retarding potential analyzer	Bourdeau, R.E.	GSFC						
			✓				X	
Map VLF noise and propagation conditions as functions of place and time (0.2 to 100 kc/s)	Helliwell, R.A.	Stanford U.						X
Obtain diurnal and latitude variations of VLF spectra (high resolution) both in orbit and on the ground (0.5 to 10 kc)	Morgan, M.G. Laaspere, T.	Dartmouth College						X
Use Paul Massenfilter spectrometer tube to obtain neutral and ionic composition of atmosphere (0-6 AMU and 0-40 AMU)	Jones, L.M. Schaefer, E.J.	U. of Mich.					X	✓
Bennett RF ion mass spectrometer for direct measurement of ion composition and density (1-45 AMU)	Taylor, H. Brinton, H.C.	GSFC					X	✓
Measure atmospheric density with Bayard-Alpert ionization gauge (10^{-5} to 10^{-10} mmHg)	Newton, G.P.	GSFC					X	✓

S A T E L L I T E S

Project Designation and Contacts	Experimenters	Affiliations	I					
			A	P	A	P	F	P
<u>OGO-C&D (Contd.)</u>								
Determine time variation in solar X-ray emission using an ionization chamber (0.5 to 3Å, 2-8Å, 8-16Å, and 44-60Å)	Kreplin, R.W. Chubb, T.A. Friedman, H.	NRL	✓			X	X	
Monitor the spectral distribution of energy (170 to 1700Å)	Hinteregger, H.E.	AFCRL	✓			X	X	
Measure cosmic noise at two fixed frequencies in the 2 to 4 Mc/s range	Haddock, F.T.	U. of Mich.	X	✓				✓
<u>INTERNATIONAL SATELLITE (UK-C&D)(Fellows/Halpern)</u>								
Galactic radio noise in frequency range, 0.75 Mc to 3.0 Mc and exploration of upper ionosphere	Smith, F.G.	Cambridge U. England	✓					X
<u>SAN MARCO (SM-A and B) (Fellows/Ginter)</u>								
Using 20 Mc/s transmitter and ground-based receiver, determine electron content and ducted propagation		Italian Space Commission					X	
Determine the atmospheric density in the equatorial region and the variations from solar heating and other geophysical phenomena		Italian Space Commission						X X

SPACE PROBES

Project Designation and Contacts	Experimenters	Affiliations	I S P R P				
			A	P	A	P	P
<u>PIONEER A&B</u>							
Determine the variations in the total electron content in the region of space between Pioneer and earth	Eshleman, V.	Stanford U.					X

SOUNDING ROCKETS

I
S'P R P
A P A P F P B

Project Designation and Contacts	Experimenters	Affiliations	A P A P F P B
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ARCAS (2 rockets) (Fellows/Holtz)

Determine correlation with RF radar information of shears and turbulence in the 60 to 90 km region	Gregory, P.	U. of Canterbury, New Zealand	X /
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AEROBEE 150A

4.45 (Opp/Holtz)

Compare different techniques for measuring electron density, and investigate electroacoustic mode	Bauer, S.J. Whale, H.A.	GSFC	X
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4.64, 4.65 (Opp/Holtz)

Joint US-Japanese experiment in the lower ionosphere to investigate the processes occurring in the lower ionosphere and to cross-check different measuring techniques	Serbu, G.P.	GSFC and Radio Res. Labs, Japan	X
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4.94 - 4.95 (Opp/Holtz)

Primary measurements to be made on components of the VLF wave field (French satellite program)	Storey, O.	CNES/CNET France	X
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SOUNDING ROCKETS

Project Designation and Contacts	Experimenters	Affiliations	I				
			S	P	R	P	P
			A	P	A	F	P
<u>AEROBEE 150A (Contd.)</u>							
4.99, 4.100, 4.101 (Opp/Holtz)	Monochromator will record the photon fluxes at a modest number of different fixed wavelengths as continuously as possible	Hinteregger, H.E. AFCRL				✓	X
<u>4.113 (Schardt/Dubin)</u>							
Determine the altitude distribution, cratering effects, and chemical structure of micrometeorites in the lower ionosphere. Determine the associated ion and electron density distribution and X-ray intensity.	Berg, O.E. Ailsen, C. Whipple, E.	GSFC				X	✓
<u>ARGO D-4</u>							
<u>8.18 (Opp/Holtz)</u>							
Elucidation of problems connected with the interpretation of topside sounder data (electron density and radio noise). Tests of next generation topside sounder techniques.	Knecht, R.W. Russell, S.	NBS, CRPL AIL					X
<u>8.19, 8.20 (Opp/Holtz)</u>							
Measure ion and electron density, electron temperature, and magnetic field in auroral conditions	Nagy, A.	U. of Mich./BRL					X

SOUNDING ROCKETS

S O U N D I N G R O C K E T S			I S P R P				
Project Designation and Contacts	Experimenters	Affiliations	A	P	A	P	P
ARGO D-4 (Contd.)							
<u>8.25, 8.26 (Opp/Holtz)</u>	In conjunction with a separate, simultaneous measurement of solar flux, measure the individual quantities which enter into the continuity equation. Some cross-checking with topside sounder data is also planned	Bourdeau, R.E. Spencer, N.W. Bauer, S.J. Taylor, H.A.				✓	X
<u>8.28, 8.30 (Opp/Holtz)</u>	Accurate determination of electron density profile by radio wave propagation between rocket and separating capsule	Nisbet, J.S.					X
<u>8.31, 8.32 (Dubin/Holtz)</u>	Measure related altitude profiles of ion composition and oxygen and hydrogen airglow for comparison of neutral and ionic species and determination of their distributions	Johnson, C.Y. Hoffman, J. Mange, P.W.					X

SOUNDING ROCKETS

IV-20

Project Designation and Contacts	Experimenters	Affiliations	I			
			S	P	R	P
			A	P	F	P
						B
<u>JAVELIN</u>						
<u>8.03 (Dubin)</u>						
Determine composition, density, and energy distribution of the atmosphere to 1,000 km	Sharp, G. McKibben, D.	Lockheed	X	✓		
<u>NIKE-APACHE</u>						
<u>14.06, 14.07 (Opp/Holtz)</u>						
Determine structure and intensity of the equatorial electrojet current in the ionosphere	Cahill, L.J. White, A.	U. of N.H.		✓	X	
<u>14.10, 14.11 (Dubin/Horowitz)</u>						
Determination of the chemical and ionic composition of the atmosphere and the generation and loss mechanisms of atmospheric constituents. Measurement of atmospheric structure variations as affected by solar radiation and particle bombardment.	Schaefer, E. Jones, L.M.	U. of Mich.				X

S O U N D I N G R O C K E T S

Project Designation and Contacts	Experimenters	Affiliations	I					
			S	P	A	P	F	P
<u>NIKE-APACHE (Contd.)</u>								
<u>14.33, 14.34 (Opp/Holtz)</u>								
E region study to correlate flux measurements with measurements of electron density	Bauer, S.J.	GSFC					X	
<u>14.37 (Opp/Holtz)</u>								
D region investigation - simultaneous measurement of a number of parameters in an effort to investigate the processes which produce the D region	Whipple, E.C. Jr.	GSFC					X	
<u>14.79 through 14.85 (Opp/Holtz)</u>								
Determine structure and intensity of the equatorial electrojet current in the ionosphere	Cahill, L.J. White, A.	U. of N.H.					✓	X

SOUNDING ROCKETS

IV-22

Project Designation and Contacts	Experimenters	Affiliations	I					
			A	P	S	P	R	P
<u>NIKE-APACHE (Contd.)</u>								
<u>14.104-14.105 (Opp/Holtz)</u>								
Particle fluxes will be measured by means of the Langmuir probe technique	Carignan, G.R.	U. of Mich.					X	
<u>14.109 (Opp/Holtz)</u>								
D region investigation - simultaneous measurement of ion and electron densities and electrical conductivity; and monitor solar UV and X-ray emissions	Whipple, E.C. Jr.	GSFC					X	
<u>14.127 (Opp/Holtz)</u>								
Measurement and comparison of radiating and non-radiating sensors for support of future space radio astronomy missions	Stone, R.G.	GSFC					✓	
<u>14.128-14.131 (Dubin/Holtz)</u>								
Investigate the tidal and dynamo motions and current systems between 80 and 200 km altitude	Sarabhai, V.	Indian Natl. Cmte for Space Research					X	

SOUNDING ROCKETS

S O U N D I N G R O C K E T S			I S P R P					
Project Designation and Contacts	Experimenters	Affiliations	A	P	A	P	F	P
<u>NIKE-APACHE (Contd.)</u>								
<u>14.143-14.149 (Opp/Holtz)</u>								
Study the ionosphere between the heights of 70 - 160 km over broad geographic areas	Bowhill, S.A. Smith, L.G.	U. of Ill. GCA						X

S U P P O R T I N G R E S E A R C H

IV-24

Project Designation and Contacts	Investigators	Affiliations	I					
			S	P	A	P	F	P B
R-74 (Opp) Support studies of solar cosmic ray emission events, by ionospheric forward scatter observations in the Antarctic during IQSY	Bailey, D.K.	NBS, CRPL				X	✓	
R-83 (Opp/Freeman) Measurement of incoherent radar backscatter using high power transmitter at 50 Mc with a large high gain antenna	Bowles, K.L.	NBS (Peru)				X		
R-101 (Opp/Freeman) Electron content, irregularities and density profiles can be obtained from information from the OGO orbits	Lawrence, R.S.	CRPL				X		
NASr-54 (05) (Dubin/Horowitz) Using a Paul Massenfilter mass spectrometer measure the properties of the upper atmosphere and conduct flight tests to obtain atmospheric composition data	Jones, L.M.	U. of Mich.				X	✓	
NASr-136 (Opp) Research to obtain information about the electron content in the ionosphere and its variation	Garriott, O.K.	Stanford U.				X		

S U P P O R T I N G R E S E A R C H

IV-25

Project Designation and Contacts	Investigators	Affiliations	I					
			S	P	R	P	P	B
NASW-513 (Easter/Gaugler) Design studies for instrumenting an experiment to sound the Venus ionosphere from the topside	Sperber, A.O. Flattau, T. Knecht, R.W.	AIL AIL CRPL	✓					
NASW-612 (Gaugler/Brown) Study program with the objective of developing a new mathematical model of radar echo information content for radar mapping of lunar or planetary surface properties	Jean, F.H.	Dikewood Corp.						
NSG-24 (Seddon) Continue studying the total electron content of the ionosphere and small scale irregularities in the F-region by Faraday rotation and differential Doppler measurements	Swenson, G.W. Jr.	U. of Ill.					X	
NSG-30 (Opp) Continuation of present program of data collection and analysis in support of the BE-A and other satellites with suitable transmissions. Faraday rotation and differential Doppler measurements are used for electron content determinations and observations on irregularities.	Garriott, O.K.	Stanford U.						
NSG-114 (Opp) Continue research to determine the electron content of the ionosphere by Faraday rotation and differential Doppler measurements on satellite signals and studies of the seasonal, diurnal, and other variations of the electron content and equivalent slab thickness	Ross, W.J.	Penn St. U.						X

S U P P O R T I N G R E S E A R C H

Project Designation and Contacts	Investigators	Affiliations	S P R P					
			A	P	A	P	F	P
NsG-118 (Easter) Theoretical study of the dynamics of the upper atmosphere	Hines, C.	U. of Chicago	X	✓				
NsG-134 (Opp/Bourdeau) Scientific portion of the program to develop the separating capsule experiment which is designed to give accurate, high-resolution electron densities by sending signals between the rocket and the separated capsule	Nisbet, J.S.	Penn St. U.						
NsG-174 (Opp) Investigation of experimental techniques for measurement of very low frequency electromagnetic phenomena in the lower ionosphere	Helliwell, R.A.	Stanford U.			X			
NsG-213 (Gaugler) Study of the scattering properties of the moon and how these properties are related to its surface structure	Hale, W.L. Tice, T.E.	Ohio St. U.		✓				X
NsG-220 (Opp/Freeman) Conduct theoretical studies of the low density plasmas encountered in interplanetary space and the interaction between this plasma and the earth's magnetic field	Tidman, D.A.	U. of Md.					✓	X

S U P P O R T I N G R E S E A R C H

Project Designation and Contacts	Investigators	Affiliations	I R P					
			S	P	A	P	F	P
NsG-224 (Moore) Study of polarization of the decametre-wave radiation from Jupiter	Barrow, C.H.	Fla. St. U.		X				
NsG-234 (Moore) Design and development of flight radar for planetary investigations	Reintjes, J.F.	MIT						X
NsG-329 (Easter) Radio propagation techniques for the study of planetary ionospheres and inter-planetary medium	Garriott, O.K.	Stanford U.						
NsG-377 (Easter) Program of lunar and planetary research with radio and radar astronomy techniques	Eshelman, V.R.	Stanford U.						
NsG-379 (Opp) Determine the optimum organization and techniques for a world-wide investigation of the D and lower E regions of the ionosphere in relation to the IQSY	Bowhill, S.A.	U. of Ill.						
NsG-395 (Opp) Study of selected radiation and propagation problems related to antennas and probes in magneto-ionic media	Deschamps, G.A. Mittre, R. Lo, Y.T.	U. of Ill.						

S U P P O R T I N G R E S E A R C H

Project Designation and Contacts	Investigators	Affiliations	S P R P					
			A	P	A	P	F	P
NsG-419 (Moore/Fellows) Electromagnetic investigation of planetary atmospheres	Barrett, A.H. Graham, J.W. Rafuse, R.P.	MIT	X	✓	✓			✓
NsG-432 (Moore) Research on millimeter wavelength radia- tion from solar bodies in support of solar system probes	Tolbert, C.W.	U. of Texas			✓			X
NsG-477 (Gaugler) Determine radar cross-section of specific areas of the earth at 1000 km	Moore, R.K.	U. of Kansas		✓				X

SUPPORTING RESEARCH AT NASA CENTERS

TASKS	TECHNICAL MONITORS	I							
		A	P	A	S	P	R	P	P
Ames Research Center									
Conduct theoretical studies of models for planetary atmospheres to determine chemical composition, structure, atomic processes and dynamical behavior.	Spreiter, J.R.								
Goddard Space Flight Center									
Perform theoretical studies on three body collisions.	Hess, W.N.								
A program directed toward an experimental study of the behavior of RF antennas and probes in a plasma and the development of ion composition and radiation detectors for studies of the lower ionosphere and the development of accurate and reliable instrumentation and techniques for spaceborne radio astronomy.	Stone, R.								
Purchase of equipment and training of personnel to operate three Brazilian stations to observe radio signal from the Polar Ionospheric Beacons.	Beard, T.								
Develop analytical methods to obtain a better understanding of planetary atmospheres and devise concepts for simple experiments and probes which can be flown into these atmospheres. Development of sensors includes pressure gages, temperature gages, gas composition measurement devices, diaphragm gages, mass spectrometers, and optical devices.	Spencer, N.W.								

SUPPORTING RESEARCH AT NASA CENTERS

TASKS	TECHNICAL MONITORS	I							
		A	P	A	P	F	P	F	P
Marshall Space Flight Center									
Measurement of ionospheric electron content. Current Mechtlly, E.A. plans are to receive signals from the Polar Ionosphere Beacons and subsequent earth satellites having appropriate transmitters.					X				
Study of physical chemical reactions of interest in the upper atmosphere with special emphasis on the behavior of water under intense solar radiation.	Frary, S.G.			X	✓				

PARTICLES AND FIELDS PROGRAMOBJECTIVES:Energetic Particles

The energetic particles program is concerned with the study of particles of energy greater than a few electron-volts which are found in the trapped and auroral radiation, solar and galactic cosmic radiation and interplanetary plasmas. Eventually, the trapped and auroral radiation associated with the other planets will be studied. The interaction between the charged particles and the magnetic fields is such that they must be studied simultaneously on the same vehicles in order to understand the phenomena. It is also necessary to make simultaneous measurements at widely separated points, such as on the ground, above the earth in balloons and sounding rockets, in the near magnetosphere using polar nearly-circular satellite orbits, in the far magnetosphere and just beyond using highly eccentric satellite orbits, and in interplanetary space. Certain of the phenomena are related to the 11-year solar cycle, and it is necessary to monitor them over an 11-year period. The present period is very nearly that of minimum solar activity.

Galactic cosmic radiation consists of a low flux of electrons, protons, alpha particles and nuclei of heavier atoms. These particles range in energy from an as yet undetermined lower limit below 10 Mev to an as yet undetermined upper limit in excess of 10^{19} electron volts. The flux varies by a factor of two over the 11-year solar cycle and occasionally decreases sharply for a few days after a solar flare--the so-called Forbush decrease.

The origin of the particles, the mechanism by which they are accelerated to high energies, the nature of the mechanism (or mechanisms) which produces the 11-year solar cycle and the Forbush modulation of the flux--these are some of the questions which have shaped the galactic cosmic radiation experimental program.

After some, but not all, major solar flares, the intensity of the positively-charged component of cosmic rays has been observed to increase by an amount which varies from barely detectable increases up to increases four orders of magnitude above the cosmic ray background for particles in the energy range from one to several hundred Mev. These particles are given the name solar cosmic rays. The intensity reaches a maximum about one to ten hours after the flare and then begins to decrease, returning to the normal background cosmic ray value about one week after the flare. There is considerable variation in the intensity, duration and energy spectrum from event to event. Solar activity prior to the solar flare and the resulting changes in the interplanetary magnetic fields influence the time required for the particles to reach the earth, the energy spectrum, and the duration and intensity of the event. Therefore, it is important to monitor continuously the intensity of the radiation in interplanetary space, together with measurements of the interplanetary magnetic field. Information is needed on as many of the events as possible to improve statistical interpretations.

Recently Explorer XII and XIV have added to the detailed knowledge of solar cosmic ray events, particularly in the use of diffusion theory and the observation of energy changes with time. Efforts to extrapolate these observations have produced a "source spectrum" of the flare particles. This has the form of a power law in energy over several decades for the three events analyzed so far. Other cases in which there are marked interplanetary disturbances between the earth and the sun do not display this characteristic.

The fundamental questions which shape the solar cosmic radiation experimental program are:

- (1) The unidirectional spectral intensity of the particles and the variation of this quantity with time and space during as many events as possible.
- (2) The nature of the accelerating mechanism on the sun.

(3) The effects of the conditions in interplanetary space on the duration, intensity, and the spatial and angular distribution of the particles.

(4) Variation of the frequency and intensity of these events with time over several solar cycles.

The trapped radiation exists in the region around the earth known as the magnetosphere. Trapped radiation is observed from about 400 miles above the surface of the earth out to the boundary of the geomagnetic field which occurs at about 40,000 miles on the sunlit side of the earth. The geomagnetic field and the trapped radiation appear to terminate at the same place. The characteristics of the radiation vary with position in the trapping region. There is an inner region which is stable with time and characterized by a high intensity of protons with energies in the range from a few kev to several hundred Mev. The energy spectrum has been observed to vary with position but there is very little variation in intensity with solar activity. Although this region is characterized particularly by high energy protons, there is also a high flux of electrons. Farther out, at about 10,000 miles, there is a region characterized by a high flux of low energy protons. This may be the region associated with the geomagnetic ring current. Also in this region the trapped radiation is characterized by electrons with energies extending up to several Mev, exhibiting large temporal and spatial fluctuations in their intensity. The lower energy electrons, below about 1 Mev, are found to be precipitated more or less continuously into the upper atmosphere in such numbers that, were there no sources, they would disappear entirely from this outer region in a few hours. This leads to the hypothesis that there must exist one or more mechanisms for the acceleration of such particles in the vicinity of the earth to replenish the supply and populate the outer region.

The detailed behavior of these rapidly fluctuating particle intensities and their relation to the associated

phenomena of VLF emissions, aurora, and the solar wind is in the initial phase of investigation and understanding.

Some of the major questions associated with the areas of trapped and auroral radiation are:

- (1) Origin of the radiation in the various regions of the belt.
- (2) Lifetime and trajectories of the particles.
- (3) Nature of the local accelerating mechanisms.
- (4) Relation between the trapped and auroral radiation.
- (5) Effects of the trapped radiation on the atmosphere and ionosphere.
- (6) Existence and nature of the trapped radiation belts around the other planets and the moon.

The shape of the magnetosphere boundary has recently undergone preliminary experimental investigation by Explorers X, XII and XIV. This boundary is caused by the pressure of the solar wind impinging on the geomagnetic field. It has been found to be generally arch-shaped with the flared open end always on the night side of the earth and the point of closest approach to the earth being at about 10 earth radii on the sun-earth line. The boundary itself is readily recognizable in the data by the sudden discontinuities in both particle and magnetic field intensities.

Fundamental questions in this area are:

- (1) Detailed investigation of the shape of the boundary in all directions, particularly over the geomagnetic poles and in the rear of the cavity.

(2) Investigation of the detailed nature of the solar wind plasma exterior to the boundary.

(3) Investigation of the effects of the boundary on the shape of the earth's radiation zones.

Recent measurements have shown that there is a plasma in interplanetary space with a density of about 10 particles/cm³ and with energy of about 500 ev traveling radially outward from the sun.

The fundamental questions in this area are:

(1) Determination of the direction and the unidirectional spectral intensity of the particles and the variations of this with time, position and solar activity.

(2) Relation of the spectral intensity to the magnetic field at the same point and at the same time.

(3) Studies of the time variations from short periods (the effects of hydromagnetic waves) to periods of 11 years (solar cycle).

(4) Determination of the chemical composition of the plasma and the temperature of each constituent.

The Magnetic Field Program:

The Magnetic Field Program encompasses measurement of the magnetic fields of the sun, planets, and natural satellites of the solar system, and of interplanetary and galactic space.

Experiments are to be carried out in conjunction with the scientific investigation of the physical processes causing the fields and their time changes. Simultaneous measurements of particle fluxes and plasma densities are required to understand the interaction between these phenomena and the magnetic field.

The major problems and objectives of the program are as follows:

(1) To survey the geomagnetic field in as great detail as possible over the whole earth, to be repeated at no less than five-year intervals. Present plans for IQSY (International Year of the Quiet Sun) call for a World Magnetic Survey in 1964-1965. As a part of this Survey, magnetometers will be flown on polar orbiting satellites and it will be possible to make measurements of the fields to an accuracy of better than ± 5 gamma. These measurements will be made at an altitude of approximately 500 km at points spaced 10 km along a trajectory with the minimum spacing between trajectories of about 400 km at the equator.

(2) To investigate the sources, presumably ionospheric, of electric current systems that give rise to such ground-observed phenomena as the diurnal magnetic variations; more pronounced variations caused by the equatorial electrojet; and the magnetic storm changes, particularly the polar disturbances. Studies recently carried out near the equator indicate that the equatorial electrojet does exist. Further sounding rocket investigation of the equatorial electrojet is planned. This work is to be done in conjunction with electron density measurements.

(3) To study the character of the outer geomagnetic field including the rapid fluctuations that may be related to hydromagnetic waves in the exospheric plasma. Vehicles for such studies need to be eccentric orbiting satellites with apogees in excess of 15 earth radii. These satellites must be launched in various directions into the magnetosphere; toward the rear of the geomagnetic cavity, toward the interesting polar regions, as well as toward the compressed sunlit side of the magnetosphere. An interesting possibility for continuously monitoring field changes with a minimum of ground equipment would be a "geostationary" satellite at about six earth radii so as to have a 24-hour period and remain stationary for long periods of time over one geographic area.

(4) To study the boundary region of the earth's magnetic field and the turbulent region immediately beyond this boundary. Eccentric orbiting satellites with apogees near 20 earth radii will suffice for boundary investigations on the sunlit side of the magnetosphere and in the polar regions. For boundary investigations toward the dark side of the earth, satellites with highly eccentric orbits and deep space probes will be needed. Magnetic measurements of low fields (of the order of 10 gamma) with high frequency response are needed in the investigation of the turbulent layer. The measurements must give the direction as well as the magnitude of the fluctuating fields.

(5) To study the interplanetary magnetic field presumably due to "frozen" fields in plasma clouds ejected from the sun and the hydromagnetic disturbances traveling through these clouds. For this purpose, two types of missions are needed: (a) the deep space probe with primary emphasis on approaching the sun as closely as possible; and (b) a far satellite in order to be free from direct effects of the earth's field and monitor the interplanetary field near the earth's orbit.

(6) To study the magnetic fields of the earth's moon and of the other planets beginning with Mars and Venus. Basically, this would be a study of the permanent magnetic fields of these bodies by planned near misses with space probes. The initial information desired about the magnetic fields of the moon, Mars and Venus is the existence or absence of such fields. The approximate magnitude of the field and the orientation of the poles should be determined also. From such measurements, together with the theory of the origin of planetary magnetic fields, it may be possible to understand something of the internal structure of the moon and the planets.

(7) In order to realize the scientific objectives of the experiments in which emphasis is placed on the time variations of the magnetic field, it is very desirable to combine measurements with those of the particle environment of the probe. It is also essential that earth-based observations be

made simultaneously with observations from spacecraft. Theoretical studies in support of the satellite and rocket measurements are essential.

TECHNIQUES AND INSTRUMENTS:

AVAILABLE:

The basic instruments used in measurements of energetic particles are the ionization chamber, the Geiger counter, the scintillation counter, the Cerenkov detector and nuclear emulsions. Solid state detectors have been developed and are now in use. The ionization chamber measures the total amount of ionization produced both by charged particles and electromagnetic radiation. The Geiger counter detects any charged particle with sufficient energy to penetrate its walls. The scintillation counter and the solid state detectors can be used to identify particles and to measure their charge and energy. The Cerenkov detector can be used to determine the direction of travel of a particle. Nuclear emulsions are similar to ordinary photographic emulsions except that they are much thicker and their grains blacken when struck by a charged particle. Emulsions can be used to measure the velocity, mass, charge and direction of travel of a charged particle. However, in order to obtain these data, the emulsions must be recovered.

Scintillation counters, Cerenkov counters and solid state detectors give out pulses which are related to the energy lost by a particle in the counter. Pulse height analyzers have been built which can determine the size of such a pulse and store it in the appropriate channel for later transmission to the ground. Such information can be used to measure the energy spectrum of the charged particles. The shape of the pulse from a scintillation counter can be used to distinguish between protons and electrons.

There are four major types of magnetometers in use at the present time--the search coil, the fluxgate, the proton precession, and rubidium vapor magnetometer.

The search coil magnetometer consists either of a coil of wire mounted in a spinning vehicle to measure the dc field or of a triaxial search coil mounted in a stabilized vehicle to measure the changes in the vector field. In the first case, the voltage output from the coil is a measure of the scalar field at right angles to spin axis of the rocket. In the second case the voltage output from one axis of the search coil is a measure of the rate of change of the magnetic field through the coil.

The fluxgate magnetometer gives a voltage output proportional to the component of the magnetic field parallel to the core of magnetometer.

The output of a proton precession magnetometer is a signal with frequency proportional to the proton magnetic moment and the strength of the local field. The proton magnetic moment is known very accurately; therefore, the field can be determined to the accuracy with which the frequency is measured. This instrument is used for measuring very accurately the total field in the region from the surface of the earth to an altitude of about 2000 km.

The rubidium vapor magnetometer is similar to the proton instrument, but the atomic magnetic moments are utilized. Optical pumping into certain Zeeman sublevels is employed to attain phase coherence of atoms in the Rb vapor sample. Using the vapor cell in a feedback loop self oscillation is attained with a continuous precessive signal. This instrument may be used in fields as low as a few gammas.

Under Development:

Detectors are under development to measure the flux, composition and energy spectra of particles with a charge greater than three fundamental charge units. Solid state detectors to replace the heavier scintillation counters, and photodiodes to replace photomultiplier tubes, are under development. Spark chambers, bubble chambers, and luminescent chambers are under development for possible space use. The path of a charged particle is made visible and preserved photographically or electronically for study.

These tracks, similar to nuclear emulsion tracks, yield information about the charge, mass, and energy of the particles. It may be feasible to telemeter this information so that vehicle recovery is not necessary.

A helium magnetometer is also under development. The helium magnetometer is similar to the rubidium vapor magnetometer except that helium gas is used rather than rubidium vapor.

S A T E L L I T E S

Project Designation and Contacts	Experimenters	Affiliations	I			
			S	P	R	P
			A	P	A	P
			B	B	B	B
AIR DENSITY/INJUN EXPLORERS (AD/I-B, AD/I-C) (Miller/Freeman)						
INJUN Explorer Measurement of downflux of corpuscular radiation with 16 detectors in the energy ranges between 0-22 Mev for electrons and between 0-40 Mev for protons to determine heating effects by the enhanced drag on the Air Density Satellite	Van Allen, J.	SUI				
					X	
Determine the contribution of precipita- ting low energy ions and electrons to the heating of the upper atmosphere	Sagalyn, R.	AFCRL				
					X	

S A T E L L I T E S

I

S P R P
A P A P F P BProject Designation and ContactsExperimentersAffiliationsEnergetic Particles Explorer (EPE-D) (Ehrlich/Freeman)

Determine rough energy spectrum in the artificial radiation belt

Brown, W.L.

Bell Telephone Lab.

X

Measure omnidirectional intensity of electrons (3.5 Mev) and of protons (35 Mev) using a spherical plastic scintillator of one cm diameter.

McIlwain, C.

U. of Calif. San Diego

X

Determine angular distribution of electron flux in the artificial radiation belt

Brown, W.L.

Bell Telephone Lab.

X

Determine absolute intensity and angular distribution of electrons (0.5 and 0.8 Mev)

McIlwain, C.

U. of Calif. San Diego

X

Measure particle fluxes, types, and energy of ions and electrons as functions of direction, time, and position in space relative to the Van Allen radiation belt

Davis, L.R.

GSFC

X

Measure the magnitude and direction of the earth's magnetic field between 1.7 and 3.5 earth radii by use of a two-axis saturable core magnetometer

Cahill, L.

U. of N.H.

X

S A T E L L I T E S

Project Designation and Contacts	Experimenters	Affiliations	I					
			S	P	R	P	A	P
<u>EPE-D (Ehrlich/Freeman) (Contd.)</u>								
Study of damage experienced by four units of differently protected solar cells of the N-on-p type	Slifer, L.	GSFC						X
<u>INTERPLANETARY EXPLORERS (IMP-A, B&C) (Freeman/Ehrlich)</u>								
Magnetic field measurements using Rb vapor and fluxgate magnetometers	Ness, N.F.	GSFC						X
Measure flux and energy of interplanetary plasma; electrons and protons (0 to 8 kev)	Rossi, B.	MIT						X
Measure solar and galactic protons and alpha particles (5 to 200 Mev)	Simpson, J.A. Gloecker, G.	U. of Chicago						X
Identify and measure energies and pitch angle distributions of trapped particles	Anderson, K.A.	U. of Calif. Berkeley						X
Measure solar and galactic protons (10 to 100 Mev)	McDonald, F.B. Ludwig, G.	GSFC						X
Measure interplanetary plasma flux and velocity protons (0.2 to 2 kev)	Wolfe, J.	Ames						X
Planar trap ion-electron detector for plasma measurements in thermal energy range (0 - 10 ev)	Serbu, G.P. Bordeau, R.	GSFC						X

S A T E L L I T E S

I

S P R P

A P A P F P B

Project Designation and Contacts

Experimenters

Affiliations

ORBITING SOLAR OBSERVATORY (OSO-C) (Roman/Mitchell)

Detect and identify electrons and protons

Bloom, S.
Schrader, C.
Waggoner, J.
Kaifer, R.

UCLRL

X

Measure charge and energy spectra of particles of energies 3.3 Mev/nucleon

Hafner, E.M.
Kaplon, M.F.

U. of Rochester

X

ORBITING SOLAR OBSERVATORY (OSO-D) (Wheel)
(Smith/Halpern)

Detect and identify electrons with energy greater than 60 kev and protons with energy greater than 2 Mev

Waggoner, J.A.
Bloom, S.D.
Schrader, C.D.
Kaifer, R.

U. of Calif.
Livermore

X

S A T E L L I T E S

S A T E L L I T E S			I					
Project Designation and Contacts	Experimenters	Affiliations	A	P	A	P	F	P
ORBITING GEOPHYSICAL OBSERVATORY (OGO-A&B) (Schardt/Ashworth)								
Measure solar cosmic ray protons (10 to 90 Mev) and solar X-rays using scintillation detectors	Anderson, K.A.	U. of Calif. Berkeley	✓					X
Detect and measure positrons (0 to 3 Mev) and monitor solar proton bursts (30 kev to 1.2 Mev)	Cline, T.L. Hones, E.W.	GSFC	✓					X
Using an ion-electron scintillation detector study spatial and temporal fluctuations by observing trapped electrons with directional energy flux, 10 kev E 100 kev, and of protons with directional intensity, 120 kev E 4.5 Mev	Davis, L.R.	GSFC						X
Determine charge and energy spectra of the primary radiation using a cosmic ray telescope	McDonald, F.B. Ludwig, G.	GSFC						X
Curved plate spectrometer used as plasma probe to measure proton concentrations (10 ⁻² to 10 ⁻⁴ particles/cm ³) as a function of proton energy (0.2 to 20 kev)	Wolfe, J. Hones, E. W.	Ames Institute for Def. Analysis						✓ X

S A T E L L I T E S

Project Designation and Contacts	Experimenters	Affiliations	A	P	A	P	F	P	B
OGO-A&B (Schardt/Ashworth) (Contd.)									
Proton and electron Faraday cup plasma probes to measure proton flux and energy spectrum, and their variations (10 ev to 10 kev)	Bridge, H. Bonetti, A. Rossi, B. Lazarus, A.J. Scherb, F	MIT							X
Using charged particle telescope, investigate low energy galactic cosmic radiation and study protons above 0.2 Mev and other nuclei at higher energies	Simpson, J.A. Fan, C.Y. Meyer, P.	U. of Chicago							X
Measure omnidirectional intensities of outer belt electrons	Van Allen, J.A. Frank, L.A.	SUI							X
Study injection, trapping, and loss mechanisms in the trapped radiation belts	Winckler, J.R. Arnoldy, R.L.	U. of Minn.							X
Detect and investigate fluctuations in vector magnetic field (0.01 to 1,000 cps), using triaxial search coil magnetometer	Smith, E.J. Holzer, R.E.	JPL UCLA							X
Use Rb vapor and fluxgate magnetometers to measure magnitude and direction of magnetic field (1 to 50,000 gammas)	Heppler, J.P.	GSFC							X

S A T E L L I T E S

Project Designation and Contacts	Experimenters	Affiliations	I					
			S	P	R	P	A	P
OGO-A&B (Schardt/Ashworth) (Contd.)			✓	✓	✓	✓	✓	✓
Spherical three-electrode probe to measure densities and energy distributions of charged particles (to 1.0 kev) as functions of position and time	Sagalyn, R.C. Smiddy, M.	AFCL	✓	✓	✓	✓	✓	✓
Planar ion and electron trap to measure densities, temperatures and energy distributions of charged particles of both polarities as functions of position and time	Whipple, E.C. Jr.	GSFC	✓	✓	✓	✓	✓	✓
ORBITING GEOPHYSICAL OBSERVATORY (OGO-C&D) (Fellows/Ashworth)								
Study low energy protons and nucleons (0.3 to 30 Mev) using a scintillation telescope	Simpson, J.A. Stone, E.C. Fan, C.Y.	U. of Chicago						X
Measure rigidity and charge spectrum of galactic and solar cosmic rays	Webber, W.R.	U. of Minn.	✓					X
Study origin and fluctuation mechanisms for the trapped radiation belts by measuring trapped and dumped electrons, using Geiger tubes as detectors	Van Allen, J.A. Frank, L.A.	SUI					✓	X

S A T E L L I T E S

S A T E L L I T E S			I		
Project Designation and Contacts	Experimenters	Affiliations	A	P	P
<u>OGO-C&D (Fellows/Ashworth) (Contd..)</u>					
Study fluctuations in the trapped radiation by measuring low energy trapped radiation and auroral particles (electrons, 10-100 kev; protons, 100 kev to 4.5 Mev) using an ion-electron detector	Davis, L.R.	GSFC			
	Konradi, A.				
	Hoffman, R.A.				
	Williamson, J.M.		✓		X
Measure magnetic field fluctuations in the low and sub audio range using a tri-axial search coil magnetometer	Holzer, R.E.	UCLA			
	Smith, E.J.	JPL			X
Measure scalar magnetic field for World Magnetic Survey, using a Rb vapor magnetometer	Borison, H.R.	GSFC			
	Cain, J.				X
	Heppner, J.P.				X
Monitor cosmic and trapped radiation using an integrating ionization detector	Anderson, H.R.	JPL			
	Neher, H.V.	CIT			X

S A T E L L I T E S

I

S P R P

A P A P F P B

Project Designation and Contacts

Experimenters

Affiliations

RELAY B & C, COMMUNICATIONS SATELLITE (Jaffe)

Determine proton energy spectrum
(2.5 E 25 Mev)

Brown, W.

Bell Tele-
phone Lab.

X

Determine electron energy spectrum
(2.5 \leq E 25 Mev)

Brown, W.

Bell Tele-
phone Lab.

X

Determine integral omnidirectional
flux of protons (E 5 Mev)

McIlwain, C.

SUI and UCSD

X

Determine directional intensity and
energy distribution of electrons
(0.4 E 1.2 Mev)

McIlwain, C.

SUI and UCSD

X

Determine directional intensity and
energy distribution of protons ($1 \leq E \leq$
8.2 Mev)

McIlwain, C.

SUI and UCSD

X

Determine directional intensity and
energy distribution of protons
(18 E 60 Mev)

McIlwain, C.

SUI and UCSD

X

SPACE PROBES

I

S P R I P

Project Designation and Contacts

Experimenters

Affiliations

A P A P F P B

MARINER C&D (Weldon/Reiff)

Study spatial and temporal changes in the interplanetary magnetic field, using a helium magnetometer

Smith, E.
Coleman, P.J.
Davis, L.
Jones, D.E.

JPL
UCLA
CIT
Brigham Young U.

X

Study temporal and spatial variations in ionizing radiation using an ion chamber and GM tube

Neher, H.
Anderson, H.R.

CIT
JPL

X

Monitor cosmic rays and determine gradients in protons and alphas, using a telescope with solid state detectors

Simpson, J.

U. of Chicago

X

Determine the temporal and spatial variations in the energy and direction spectra of the solar plasma

Bridge, H.
Lazurus, A.J.
Snyder, C.W.

MIT
MIT
JPL

X

Search for trapped particles at Mars. Monitor solar cosmic rays and energetic electrons in space

Van Allen, J.A.
Frank, L.A.
Krimigis, S.M.

SUI
SUI
SUI

X

SPACE PROBES

I

S P R P
A P A P F P B

Project Designation and Contacts	Experimenters	Affiliations	A	P	A	P	F	P	B
<u>PIONEER A & B (Weldon/Reiff)</u>									
Monitor the magnetic field in inter-planetary space using a fluxgate magnetometer	Ness, N.F.	GSFC						X	
Monitor the energy and direction spectra of the plasma in interplanetary space using a Faraday cup with split collector, electrometer detector	Bridge, H.	MIT						X	
Monitor and determine the gradients in cosmic ray proton and alpha fluxes and hence determine the modulating effects of magnetic fields	Simpson, J.	U. of Chicago						X	
Monitor the energy and direction spectra of the plasma in interplanetary space using an eight plate quadraspherical collector with electrometer detector	Wolfe, J.	Ames						X	
Determine the anisotropy of the low energy portion of the cosmic radiation	McCracken, K.G.	GRCSW						X	

OTHER FLIGHT EXPERIMENTS

V-22

Project Designation and Contacts	Experimenters	Affiliations	I					
			A	P	A	P	P	P
<u>BALLOON (Freeman/Ehrlich)</u>								
Study cosmic ray fluxes at high latitudes	Winckler, J.	U. of Minn.						
Study auroral X-rays at balloon altitudes	Webber, W. Waddington, C.		✓					X
Determine the variations in the flux and energy spectra of the primary cosmic ray electrons, positrons, protons and alpha particles at different intervals during a complete solar cycle	Meyer, P. Fan, C.Y.	U. of Chicago						X
Study of electron precipitation in the auroral zone	.Anderson, K.	U. of Calif. Berkeley						X
Determine the charge spectrum of primary cosmic rays of energy greater than 1 Bev	Parnell, T.	U. of N.C.						X
Investigation of cosmic radiation anisotropies	McCracken, K.G.	GRCSW						X
<u>BALLOON (Smith/Ehrlich)</u>								
Charged particle detector sensitive to the L group of nuclei (3 Z 5), relativistic particles (0.72), protons corresponding to 0.35	Kaplon, M.	U. of Rochester						✓

SOUNDING ROCKETS

V-23

SOUNDING ROCKETS			I						
Project Designation and Contacts	Experimenters	Affiliations	A	P	A	P	F	P	B
NIKE-APACHE									
<u>14.06, 14.07 (Opp/Holtz)</u>									
Determine structure and intensity of the equatorial electrojet current in the ionosphere	Cahill, L.J. White, A.	U. of N.H.				✓	X		
<u>14.43-14.44, 14.118-14.120 (Freeman/Holtz)</u>									
Measurement of the high latitude auroral radiation using zero wall thickness detectors	Evans, D.L.	GSFC					X		
<u>14.79 through 14.85 (Opp/Holtz)</u>									
Determine structure and intensity of the equatorial electrojet current in the ionosphere	Cahill, L.J. White, A.	U. of N.H.				✓	X		
<u>14.121-14.124 (Freeman/Holtz)</u>									
Measure auroral light, particle flux and UV and gamma flux	Murcary, W.	U. of Alaska					X		
<u>14.150-14.154 (Freeman/Holtz)</u>									
Studies of energetic auroral electrons and protons	O'Brien, B.J.	Rice U.	✓				X		

SOUNDING ROCKETS

Project Designation and Contacts	Experimenters	Affiliations	I				
			S	P	R	P	P
NIKE-APACHE (Contd.)			A	P	A	P	P
<u>14.155-14.160 (Freeman/Holtz)</u>							
Measure magnetic fields in the ionosphere and auroral electra jet	Davis, N.	GSFC					X

S U P P O R T I N G R E S E A R C H

Project Designation and Contacts	Investigators	Affiliations	I S P R P					
			A	P	A	P	F	P B
R-74 (Opp) Support studies of solar cosmic ray emission events, by ionospheric forward scatter observations in the Antarctic during IQSY	Bailey, D.K.	NBS, CRPL	X				✓	
NASr-21 (05) (Schardt) Conduct theoretical studies of the charged particle populations of the trapped radiation belt	Vestine, E.H.	RAND Corp.					X	
NASr-79 (Freeman) Reduction and analysis of the ionization chamber data from Explorer VII	Pomerantz, M.	Franklin Inst. Bartol Res. Foundation					X	
NASr-116 (Freeman) Experimental and theoretical investigation of geomagnetically trapped particles	McIlwain, C.E.	UCSD					X	
NASr-164 (Freeman) Measurement of neutron intensities in space	Lockwood, J.A.	U. of N.H.					X	
NASr-198 (Freeman) Development of prototype satellite instrumentation for cosmic ray anisotropy studies	McCracken, K.	GRCSW					X	

S U P P O R T I N G R E S E A R C H

Project Designation and Contacts	Investigators	Affiliations	I					
			S	P	R	P	A	P
NASw-155 (Opp/Freeman) Develop and test magnetometer systems for rocket and satellite research	Cahill, L.J.	U. of N.H.					X	
NASw-698 (Gaugler) Theoretical study of the coupling between the solar wind and the exosphere	Scarf, F.L.	STL					X	✓
NASw-699 (Freeman) Perform theoretical calculations of the spectrum of elementary particles pro- duced by the collision of cosmic rays with interstellar gas	Milford, S.N.	Grumman Air- craft Engr. Corp.					X	
NSG-118 (Easter) Theoretical study of the dynamics of the upper atmosphere	Hines, C.	U. of Chicago					X	✓
NSG-144 (Freeman/McDonald) Investigations of primary electrons, posi- trons, and protons in the high latitude cosmic ray flux with satellites and balloons	Meyer, P.	U. of Chicago						X

S U P P O R T I N G R E S E A R C H

Project Designation and Contacts	Investigators	Affiliations	I					
			S	P	R	P	F	P
			A	P	A	P	F	P
NsG-176 (Smith) Theoretical investigation of the inter- action of solar flare particles with coronal plasma	Oster, L.	Yale U.	X				✓	
NsG-179 (Freeman/McDonald/Ludwig) Experimental and theoretical studies of energetic particles and electrodynamical processes in interplanetary space and in the vicinity of planets	Simpson, J.	U. of Chicago						X
NsG-185 (Freeman/Fichtel) Determine some characteristics of high altitude primary cosmic radiation at low and/or southern latitudes	Friedlander, M.W.	Washington U.					X	
NsG-201 (Freeman/Naugle) Interpretive and theoretical study of ring current effects and geomagnetic field phenomena	Akasofu, S. Chapman, S.	Geophysical Inst. of Alaska					X	
NsG-220 (Opp/Freeman) Conduct theoretical studies of the low density plasmas encountered in inter- planetary space and the interaction between this plasma and the earth's magnetic field	Tidman, D.A.	U. of Md.					✓	X

S U P P O R T I N G R E S E A R C H

I

S P R P

A P A P F P B

Project Designation and Contacts	Investigators	Affiliations	A	P	A	P	F	P	B
NsG-233 (Schardt) Theoretical and experimental studies related to the particles and fields associated with the major bodies of the solar system and with interplanetary space	Van Allen, J.A.	SUI							X
NsG-249 (Liddel) Design, develop, and construct a single flight prototype of a low energy proton detector	Farley, T.A.	UCLA							X
NsG-281 (Schardt) Analytical and experimental research in galactic and solar cosmic radiation, trapped radiation, and zodiacal light	Winckler, J.R. Ney, E.P. Kellogg, P. Webber, W.	U. of Minn.							X
NsG-283 (Freeman) Techniques for extraterrestrial measurement of low energy charged particle fluxes in the interplanetary plasma	Wilkerson, T.D.	U. of Md.							X
NsG-332 (Freeman) Measurement of high energy neutron flux in space	Leavitt, C.P.	U. of N. Mex.							X

S U P P O R T I N G R E S E A R C H

I

S P R P
A P A P F P B

Project Designation and Contacts

Investigators

Affiliations

NsG-382 (Schardt)

Theoretical studies of solar system physics in the areas of magnetohydrodynamics, solar cosmic rays, orbit theory of zodiacal light particles, celestial mechanics and the capture of interplanetary dust particles

X

NsG-386 (Opp)

Development of advanced plasma detectors and the preparation of plasma experiments for NASA satellite program and interpretation of the results from these experiments

MIT

X

NsG-387 (Freeman)

Theoretical and experimental investigations of high energy solar flare radiation and of trapped radiation

Anderson, K.
U. of Calif.
Berkeley

X

NsG-406 (Freeman/Holtz)

Design, construction and flight of an auroral experiment to measure auroral light, particle flux, UV and gamma flux

Mucray, W.B.
Almasi, M.
U. of Alaska

X

NsG-417 (Schardt)

Study interaction of the solar plasma and the outer regions of the geomagnetic field

Chang, C.C.
Catholic U.

X

S U P P O R T I N G R E S E A R C H

Project Designation and Contacts	Investigators	Affiliations	I							
			S	P	A	P	R	P	P	B
NsG-426 (Gaugler) Research in selected fields of physics and astronomy and cosmic ray studies. Development of prototype detectors for high latitude solar and galactic cosmic ray research	Leighton, R.	CIT								
	Vogt, R. Neher, H.V.								X	✓
NsG-471 (Ott) Theoretical and experimental study of ionized gaseous regions in interplanetary space.	Gold, T.	Cornell U.								
			✓	✓					X	

SUPPORTING RESEARCH AT NASA CENTERS

TASKS	TECHNICAL MONITORS	I							
		A	P	A	P	P	F	P	B
Goddard Space Flight Center									
Establish and test techniques for handling, analyzing and presenting large quantities of geomagnetic field data. Conduct special studies on time variations of the geomagnetic field utilizing surface station data.	Heppner, J.P. Cain, J.C.						X		
Continue to study the effects of magnetic fields on the evolutionary history of galaxies; study problems of magnetohydrodynamics in space; and study processes occurring near null points in magnetic fields.	Hess, W.N.						X		
Development of advanced magnetometers of the alkali vapor atomic resonance type.	Heppner, J.P. Ness, N.F.						X		
Develop and test new particle detectors and data processing equipment.	McDonald, F.B.						X		
Determine the motion of cosmic rays in the earth's magnetic field, and make theoretical studies of possible trapping mechanism.	Hess, W.N.						X		
Theoretical study of ion-electron recombination. This study is aimed at extending our knowledge on problems of collision cross sections, types of possible reactions and the reaction rates.	Hess, W.N.								✓
							X		

SUPPORTING RESEARCH AT NASA CENTERS

V-32

TASKS	TECHNICAL MONITORS	I					
		A	P	A	P	F	P B
Jet Propulsion Laboratory	Lawrence, J.					X	
Design and evaluate gas sensors and electronics in terms of the spacecraft environment to provide a highly reliable absolute magnetometer which would have the wide dynamic range common to the fluxgate type, but would have the high sensitivity and null stability afforded by the gas system.	Lawrence, J.					X	
Broaden existing capability in solar plasma instrumentation by development of electronics which will allow a greater and more accurate coverage of the spectral distribution. Examine systems which will enable charged particle identification and provide ability to measure very low flux density plasma.	Lawrence, J.					X	
Measure the directionality of protons and alphas in space as a function of energy. Such data will be of particular interest for solar flare particles in that it will give information on the large scale magnetic fields between the probe and the sun which control the trajectories of the particles.	Mackin, R.J. Jr.					X	
Design a facility which permits accurate calibration of magnetometers without interference from external field fluctuations. Research on new techniques of field detection to cover a wider dynamic range as well as lower field strengths.	Thiele, C.					X	

SUPPORTING RESEARCH AT NASA CENTERS

TASKS	TECHNICAL MONITORS	I									
		A	P	A	P	F	P	B			
Jet Propulsion Laboratory (Contd.)											
Provide continuing research in geomagnetism to support Mackin, R.J. Jr. space measurements (OGO-A,B,C,D, Mariner, Ranger). Develop ground-station equipment and techniques with a view to adapting them to flight equipment. Produce a nearly field-free region, shielded from magnetic variations, for the evaluation, calibration and testing of flight magnetometers.							X				
Develop a flight mass spectrometer that will be capable Gray, F.B. of measuring the composition at the extremely low pressures found in the lunar atmosphere, solar wind, deep space, and possibly comet tails.									X	✓	✓

PLANETOLOGYOBJECTIVES:

The planetology program is concerned with the condensed material of the solar system: Planets (including earth), moons, asteroids, comets, meteorites, and related objects.

The solid objects can be studied with respect to their elemental composition; their phase composition; the combination, arrangement, and evolution, of these phases; the rock units that they constitute, and the solid objects as entities, and their history. The distribution of density within these objects contributes to an understanding of their physical history. The question of the magnetic field also is interesting for the same reason.

Ancient and possible present life forms and large scale climatic features of the planets are of interest to this discipline.

Knowledge obtained through the planetology program provides the basis for recommendations for scientific research required to permit effective accomplishment of manned lunar landings, and for the scientific programs to be carried out by man in space.

LUNAR PROGRAM:

A review of the many points of interest in connection with the Lunar Planetology program cannot be made briefly and has been covered in great detail by some very good books which we may mention: Physics and Astronomy of the Moon (1962), edited by Z. Kopal, Academic Press; The Moon (1962) edited by Z. Kopal and Z. Mikhailov, Academic Press; Symposium No. 14 of the International Astronomical Union; also, at the NASA-University Conference on the Science and Technology of Space Exploration, Vol. 1, held at Chicago, Illinois, November 1-3, 1962, Article 17 "Planetary Astrophysics

and the Exploration of the Solar System" by Ray L. Newburn, Jr., and Article 18 "Geological Exploration of the Moon and Planets" by Robert C. Speed, James E. Conel, Robert L. Kovach and Alden A. Loomis. All these give excellent summaries of recent studies that have been made. These papers do not undertake to discuss the possible origin of the moon, and in this connection a paper by Urey published in Space Science, edited by D. P. LeGalley (1963), Wiley & Sons, Chapter 4, discusses certain features of this problem. A recent paper by D. U. Wise, J. Geophys. Res. 68, 1547 (1963) presents a new theory for the escape of the moon from the earth.

All these discussions and theories are much too involved to summarize briefly but certain points may be mentioned. Two theories for the origin of the moon are being considered at present: one, that the moon was captured by the earth after having been formed in some other place -- the second, that the moon escaped from the earth during its early history. The first of these assumes that the moon accumulated independently of the earth and two variations of this theory might be mentioned, namely, that it formed in a high temperature condition in which case the outer parts of the freshly solidified moon could have a fairly acid composition mixed with debris that should have accumulated on its surface during the time that the earth accumulated; and second, that the moon accumulated cold, that melting in the outer parts took place, and that its surface was covered with some debris again during the accumulation of the earth. In this case the moon was captured in some type of orbit by the earth which of course should be a very rare event. One theory (Gerstenkorn) postulates that it was captured in a retrograde orbit, that it moved near to the earth through tidal friction, its orbit being converted to a direct orbit, and since that time it has moved away. A difference should exist in the structure of the moon depending upon whether it was completely melted in its early history or only partially melted at the surface. In the latter case, substantial bodies of metal might have been formed buried beneath its surface and may be detected by seismic reflections. In

either case, the center of the moon may be melted today and some iron may form a core.

If the moon escaped from the earth, we must expect that it is composed of a mixture of terrestrial type rocks. If it escaped as a single object, there may be some layering in the moon which is residual from layering that existed in the earth before separation. On the other hand, if the moon escaped as debris from the equator of the earth, then we should expect that it is composed mostly of the superficial rocks of the earth at the time of escape. In either case, the event must have occurred early in the history of the earth-moon system before the geological record of the last 3×10^9 years, for otherwise the very great collisional processes which are evident on the surface of the moon should also have occurred on the surface of the earth, and it is doubtful if that could have been overlooked by geologists.

The present state of the moon of course will be different from the initial condition, possibly in important ways. Thermal calculations indicate that the center of the moon may be melted, and in this case a core may exist regardless of whether it was a primitive structure or not. Investigations into the mass distribution within the moon would be able to answer questions of this kind. A core of some size is likely at the present time. Even if the moon contains only two per cent by weight of iron-nickel, it can have a core of approximately $1/5$ of the radius of the moon. Lava flows are often postulated particularly in the mare regions though arguments against these assumptions have been advanced. Return of samples from the mare areas should decide this question.

The outer parts of the moon must be partly broken material containing both metal and silicate. Interesting in this connection are the recent studies of Whitaker which indicate that possibly the entire surface of the moon consists of rubble of some kind. The thermal data on the moon's surface secured by radar studies and from the temperature of cooling during eclipses indicate a highly

insulated surface probably due to finely divided material in vacuum for some depth which cannot be accurately determined. There is evidence from the escape of C^2 from the moon as observed by Kozyrev that very highly reduced materials exist somewhere beneath its surface.

The physical shape of the moon has been studied for many years. Postulates have been made that it is due to a cold rigid structure of the moon, that it is due to a variation in chemical composition with angle, and that it is due to two convection cells rising in the directions toward and away from the earth and sinking at the limb. This problem is one which should be investigated in our studies.

The most prominent feature of the moon's surface are the great collisional effects, both large and small size. These are interesting in themselves, but their scientific importance from the standpoint of understanding the history of the moon is not nearly so great as the problems associated with understanding the features mentioned above. These surface effects are of great importance in connection with the Apollo project because of the necessity of understanding the engineering structure of the surface of the moon in order to make a manned landing and a possible return from its surface.

Much more important problems from the standpoint of understanding the moon and its history are its chemical composition, both in general and in detail, its mineralogical composition, a question as to whether the radioactive isotopes of potassium, uranium and thorium are concentrated at the surface or not, the distribution of mass throughout the moon, the absence of magnetic fields, seismic effects, the heat flow from the interior, and the age of the surface rocks as determined by the three important dating methods, the lead-lead, potassium-argon and rubidium-strontium methods.

The problem of useful substances on the moon is an important one in connection with the Apollo project. We of course should look for the substances that are contained

in the earth and meteorites. It is likely that the superficial region of the moon is more highly reduced than are the surface rocks of the earth. It should be noted, however, that highly oxidized substances do occur in the carbonaceous chondritic meteorites, such as oxidized sulfur, carbon and iron in higher oxidation states. It is probable that water, carbon, carbonaceous compounds, possibly acetylene, will be present under such conditions that they can be observed and perhaps used. It is of course to be expected that silicate rocks will be present which can be used possibly for building materials. Free metallic iron-nickel in unknown concentrations and amounts may be present.

It should be noted that the probability of finding rare or even fairly abundant minerals on the moon is unlikely. In order to have found these on the earth, geological explorations of very considerable magnitude have been necessary or they have been observed by people as they have populated the various parts of the earth. Neither extensive geological exploration nor dense populations are likely on the moon at any time in the foreseeable future. Therefore we must make our plans on the assumption that only abundant things of a useful character which can be found almost anywhere will be available.

The short-range program for Lunar Planetology has as its objectives furthering our knowledge about the moon by means of spacecraft and ground-based activities; the study of meteorite craters and impact sites on earth; investigations of meteorites, micrometeorites, and tektites; and the continuation of ground-based supporting research programs.

The primary questions we hope to answer about the moon are concerned with its origin, history, and physical and chemical composition. A few of the important areas for investigation are:

1. To determine the figure of the moon.
2. To determine the physical properties of the rocks exposed at the surface and their relationship to the original lunar material.

3. To determine the nature and distribution of the major rock units that can now be recognized on the moon. This includes their chemical and mineral composition and their topographic expression.
4. To determine the near surface distribution of radioactive material, and the interior heat loss through this surface.
5. To detect and identify gaseous emission on the lunar surface.
6. To determine the nature of the surface layers that have been subject to prolonged solar and cosmic particle bombardment.
7. To determine the relative and absolute ages of the major rock units on the moon.
8. To determine the internal constitution of the moon by means of seismometers, magnetometers, and by other physical measurements.
9. To prepare geologic maps at various scales.
10. To determine if indigenous materials can be used to support the manned program.

TECHNIQUES FOR LUNAR INVESTIGATIONS:

The basic data concerning the surface of the moon will be gathered by ground-based observations and by unmanned spacecraft within the next five-year period. These investigations will be concentrated on the leading side of the moon in the vicinity of the equator, in the same area where the manned lunar landings will be made. Work will be done in the following areas; selenodesy; topographic mapping; photogeology; ground-based radar; microwave and telescopic analysis of the lunar surface; the search for lunar fragments; and unmanned flight-supported geology and geophysics.

Selenodesy, in its broadest context, will be studied mainly through earth-based activity. First and second order triangulation points that have horizontal as well as vertical control are being measured on photographic plates and these control points are being used in the preparation of topographic maps. It is possible that a spacecraft will be placed in orbit around the moon before 1966, and the resulting data will be used to determine the figure of the moon, as well as provide the higher resolution photography needed for scientific studies of the surface.

Topographic mapping of the moon on a scale of 1:1,000,000 is being done by the Air Force Chart and Information Center, using data supplied in large part by NASA grantees. These base maps are fundamental to scientific work and direct NASA support of the present low level ACIC program will be needed in order to complete the topographic maps required for the photogeological mapping. Extension of the topographic mapping, either in areal coverage or to larger scales, will require new photography by means of orbiting spacecraft. Eventually, maps of a scale of approximately 1:100,000 will be needed for the photogeological work and the manned lunar landings. Ideally, such photography should be available before mid-1965.

Photogeological mapping of the moon began two years ago under a NASA agreement with the U. S. Geological Survey. The area 32° north and south of the equator, to the limbs, will be covered with photogeological maps in a scale of 1:1,000,000 by mid-1965. Extension of the mapping to 48° north and south should be completed by the end of 1965. Further photogeological mapping, either on 1:1,000,000 or 1:100,000 scales, will depend upon photography acquired by means of orbiting spacecraft.

Investigations of the lunar surface by means of ground-based radar and microwave began two years ago. The interpretations of these data lack resolution and are subject to some doubt, but they seem to indicate variations in surface properties between some craters and the lunar surface in general. Future work should be concentrated on perfecting the interpretational method and improving resolutions.

Photometric studies of the lunar surface tend to verify the small surface relief indicated by radar. It has been found in the laboratory that small scale, intricately-structured surfaces give photometric results comparable to those obtained from the moon.

Much could be learned about the lunar surface if we could identify the secondary particles which are knocked off the moon by meteoroid impacts. Some of these sooner or later must reach the earth's surface although students of meteorites are not now able to identify them. Chondritic or achondritic meteorites and tektites are among the candidates but it is not certain that they exhaust the possibilities. Lunar ejecta are certainly represented among micrometeorites.

Unmanned flight-supported geology and geophysics will be accomplished by means of the Ranger and Surveyor spacecraft. Beginning in 1964, flights will be made by Rangers A, B, C and D. The primary objective of these flights is to take close-up photographs of the lunar surface.

Four Surveyor engineering flights will be flown in 1965 followed by four operational flights in 1966. The purposes of the operational flights will be to:

1. Determine the mineral and chemical composition of the lunar surface materials at particular points.
2. Determine the bearing strength, topography, texture, and nature of the lunar surface at particular points.
3. Determine the number and severity of secondary rock particles created by meteorite bombardment.
4. Detect and measure seismic activity.

These unmanned-flight results will contribute greatly to the manned lunar expeditions which will start after 1966. Preliminary to a manned lunar flight, we must know the

physical condition of the lunar surface, particularly with regard to the thickness of any dust layer, and the clinging effect of this dust caused by the lack of surface oxides; the radioactivity of this surface induced by solar particles, and the flux of the secondary meteorite particles.

Ground-based research related to lunar exploration is being done in five areas: geology, geophysics and nuclear physics, geochemistry, astronomy, and radar and radio astronomy.

PLANETARY PROGRAM:

The planetary program through the late 1960's will be concerned with Mars and Venus, and will be by means of spacecraft that will fly by the planets and take TV pictures and make measurements of atmospheres, magnetic fields, and radiation belts. Balloon-borne Strato II flights will make infrared measurements of Venus and Mars. As these programs develop they will parallel the lunar exploration program now in progress.

A description of the surfaces and interiors of the planets is a first step toward the unraveling of the long-term history and evolution of the solar system. While the early stages of planetary exploration will concentrate on the study of the moon, even in these the early stages of planetary exploration it will be possible to obtain significant information about the other planets. So far, the first advance in planetology resulting from space probes launched by NASA has been the discovery that Venus does not possess a magnetic field comparable in magnitude or geometry to that of the earth. The surface temperature of Venus is also of significance to the planetology program.

A parameter of first importance in the study of planets is the moment of inertia about the axis of rotation. This moment reflects the degree to which the planet has undergone differentiation. For the terrestrial planets, the differentiation is an indication of the past thermal history since a planet that originated cold and never melted would have an

irregular mass distribution. Alternatively, the planets may have undergone a long history of partial melting and segregation as apparently is the case with the earth. In the major planets, the degree of mass concentration toward the center provides clues as to the bulk composition of the planet.

The mass distribution of a planet is critical in the understanding of the process by which planets aggregated. If the process is a statistical one and takes place at low temperatures, then the gravity field should be irregular in the sense that the harmonics drop off at a slow rate. Alternatively, if the aggregation is regular or if, after an irregular aggregation, other processes have resulted in a regular distribution, then the gravitational field should have most of its energy in the lower harmonics and drop off rapidly with high harmonics. These harmonics can best be determined by orbiting spacecraft.

Closely coupled with the question of mass differentiation is the problem of planetary magnetic fields. It is generally agreed that a planetary field must arise through the motion of a conducting fluid. In the case of the earth, the conducting fluid forms the outer core. Thus, a necessary though not sufficient condition for a magnetic field is a central core. The interpretation of the magnetic measurements of Venus requires a determination of the extent to which Venus is differentiated.

The theory of planetary magnetic fields presents many problems. Rotation acts as a constraint on the convective motion of the fluid and thus planetary rotation is not a requirement for the generation of a field, though it may play a role in the geometry of the field. The source of energy for the generation of a field remains obscure. In the earth it is generally supposed that radioactivity provides the needed heat. An astronomical origin for the field is possible with precessional torques due to the sun and moon transferring momentum from the solid mantle into the core. Measurements of the magnetic field on Mars perhaps will provide a partial answer to these questions. The satellites of Mars

are far too small to provide the required precessional torques, yet the data on the dynamic figure of Mars are compatible with the presence of a small core. If Mars has a magnetic field, then the energy source must be radioactivity.

The moment of inertia of Mars remains in doubt. The motion of the satellites provides a good estimate of the second-order coefficient in the harmonic expansion of the gravitational field. The precessional motion of the planet has not been detected. An equilibrium theory provides an estimate of the moment of inertia, an observation of the precession of Mars is required for more definitive data. The need for a more definitive value of the moment of inertia of Mars is underlined by the apparent discrepancy between the dynamic and optical figures of the planet. Observations of the atmosphere during the Mariner C flight can provide the data needed to decide whether or not Mars is a misshaped planet. The two small satellites of Mars lie accurately in the plane of the Martian equator. Since this plane is tipped at about 23 degrees to the ecliptic and since a slow precession due to the sun is likely, the question arises as to why the small satellites remain in the equator. A possible answer is the frictional interaction due to the tides. Observations of the nature of the satellites and of the surface would permit an estimation of the frictional effects. The question of the dynamics of the satellites is closely related to the general problem of the origin of satellites in the solar system. Are the satellites captured and, if so, did they arise initially in the asteroidal belt?

Mars poses further problems in that there is a chance that geologic history may be recorded in its surface rocks. It is possible that the Martian atmosphere, in the planet's earlier stage of development, contained a great deal more water vapor than at present. Temperature permitting, lakes and rivers might have existed, and an aqueous sedimentary history of this era might still be preserved on Mars. At present, we know that violent dust storms exist, so that more recent history may be recorded in eolian sedimentary sections. The seasonal variations of the planet, while

of prime interest to the Bioscience program, are also of interest to the planetology group.

The gross chemistry of the planets and asteroids is of greatest importance in understanding the earliest history of the solar system. At present, the sole information is provided by the relative densities of the terrestrial planets. The densities of the asteroids are not known since neither their mass nor their dimensions have been established. The principal anomaly is the high density shown by the planet Mercury. The density of Venus is somewhat less than that of the earth, but consistent with the hypothesis that the two planets are similar in gross chemical features. The density of Mars cannot be accounted for without further hypotheses regarding the nature of phase transitions.

This short range Planetology program does not envision any large effort related to comets. We are, however, studying the feasibility of flying by or impacting on a comet.

Instruments for Unmanned Lunar Exploration

AVAILABLE:

With the exception of the Ranger gamma-ray detector, single-component seismometer and TV equipment, spacecraft instrumentation in use and available at the present time has been developed for the exploration of the earth's high atmosphere and interplanetary space. There are no other instruments available which have been completely developed for lunar surface exploration, although some of the following instruments are in advanced stages of flight-approved testing.

UNDER DEVELOPMENT:

Vidicon camera systems for lunar approach.

Gamma-ray spectrometer for identification of
natural and induced radioactive elements.

Single axis short-period seismometer.

Television systems for medium--and high--
resolution reconnaissance of the lunar
surface.

Lunar surface sampler.

Sample handling and processing equipment.

Radiometers for determination of radiation tempera-
tures on the surface and subsurface.

Magnetic susceptibility technique for surface and
subsurface measurements.

Radiation heating and cooling technique for
determining surface and subsurface thermal
conductivities.

Configurations of detectors and explosive charges
to determine subsurface acoustic velocities
of the moon.

Techniques to determine the mechanical bearing
and shearing strength of the lunar soil.

X-ray diffractometer for mineralogical analyses.

X-ray spectrometer for elemental analyses.

Facsimile equipment for high resolution pictures.

Gas chromatograph for the analysis of volatile
gases.

Petrographic microscope.

An instrument to use the Rutherford scattering
technique for light-element analysis.

Three-axis long-period seismometer.

Three-axis fluxgate magnetometer.

Neutron activation and inelastic scattering technique for elemental analysis.

Absorption spectrophotometer for elemental analysis.

Mass spectrometer for elemental analysis.

TECHNIQUES FOR EARTH INVESTIGATIONS:

The earth investigations in the field of Planetology are limited to the study of meteorite impact sites. Work will be concerned with establishing geologic and mineralogic criteria by means of which impact sites can be identified; identifying impact sites; detailed geologic investigations of impact sites; and laboratory investigations of the physics and chemistry of hypervelocity impact.

The impact site and meteorite crater investigations are being done primarily to learn about the physics of natural impact events and to determine the flux of large meteorites in geological time. It is apparent that identification of impact sites will continue at a growing rate.

TECHNIQUES FOR METEORITE AND TEKTITE STUDIES:

For the next five years, meteorites are likely to be the only extraterrestrial materials available for study on earth. A comprehensive program is in progress that includes studies in geochemistry, mineralogy, petrography, petrology, age dating, and cosmic radiation history of meteorites. The results of these studies will be of great help in formulating and extending theories on the origin of the solar system, the original chemical composition of the solar system, and nucleogenesis within the solar system. In addition, various studies are underway that will lead to a

better knowledge of meteorite flux. We are also studying the earth trajectories of meteorites in order to determine their position of origin within the solar system.

A comprehensive study of the major and minor elements of tektites is being done by the U. S. Geological Survey. If, as some scientists believe, tektites originate on the moon, a detailed understanding of their chemical and mineralogical characteristics will be of great value.

TECHNIQUES FOR GENERAL EARTH-BASED SUPPORTING RESEARCH:

Most of the earth-based research is for direct support of lunar, earth impact site, or meteorite studies. However, some grants, of a more general nature, include basic research on the general problem of planetary interiors as well as research in geochemical instrumentation.

S P A C E P R O B E S

Project Designation and Contacts	Experimenters	Affiliations	I					
			S	P	R	P	A	P
<u>RANGERS A - D (Block III) (Cunningham/Gill)</u>								
Determine lunar topography using an RCA TV system consisting of six 1-inch vidicon cameras	Kuiper, G. Urey, H.C. Shoemaker, E. Heacock, R. Whitaker, E.	U. of Ariz. UCSD USGS JPL U. of Ariz.						X
<u>MARINER C & D (Weldon/Reiff)</u>								
Study spatial and temporal changes in the interplanetary magnetic field, using a helium magnetometer	Smith, E. Coleman, P.J. Davis, L. Jones, D.E.	JPL UCLA CIT Brigham Young U.			X			
Obtain TV pictures of Mars using optical telescope with vidicon tube	Leighton, R.B. Murray, B.C. Sharp, R.P.	CIT					✓	X
Measure mass and number of dust particles in space and in the vicinity of Mars	Alexander, W.M. Berg, O.E. Bohn, J.L. Fuchs, O. McCracken, C.W. Secretan, L.	GSFC GSFC Temple U. Temple U. GSFC GSFC					X	✓

S P A C E P R O B E S

I
S P R P

Project Designation and Contacts	Experimenters	Affiliations	A P A P P B
<u>SURVEYOR (E - H) (Block I) (Milwitzky/Zihlman)</u>			
TV surveillance of lunar surface features	Shoemaker, E.M. Kuiper, G.P. Whitaker, E.	USGS U. of Ariz. U. of Ariz.	X
Determine hardness, grain size, and mechanical characteristics of lunar surface	Scott, R.F. Haythornwaite, R.M. Liston, R.A.	CIT U. of Mich. USArmy Ord. Land Locomotion Lab.	X
Determine hardness and bearing strength of Batterson, S.A. lunar surface using strain gages, TV accelerometers, and rate gyros		Langley	X
Elemental analysis of lunar surface material	Turkevich, A. Patterson, J. Franzgrote, E.	U. of Chicago Argonne Natl. Lab. JPL	X
Determine seismic activity of the moon	Sutton, G.H. Ewing, M. Press, F.	Columbia U. Columbia U. CIT	X
Measure flux, momentum, and energy of secondary particles generated by meteoritic impacts	Alexander, W.M. Berg, O.E. Secretan, L. McCracken, C.W.	GSFC	X

OTHER FLIGHT EXPERIMENTS

Project Designation and Contacts	Experimenters	Affiliations	I					
			S	P	A	P	P	B
<u>BALLOON (Dubin/Ehrlich)</u>								
Investigate the chemical structure, terrestrial accretion rate, and mass distribution of interplanetary material collected at balloon altitudes.	Hemenway, D.C.	Dudley Obsv.						
			X					✓

S U P P O R T I N G R E S E A R C H

Project Designation and Contacts	Investigators	Affiliations	I					
			A	P	A	P	F	P
NASr-21 (04) Research leading to the preparation of tables of constants and parameters of the solar system	Schilling, G.F.	RAND Corp.						X
NASr-49 (04) (Allenby) Program on evaluation of IR spectrophoto- metry for compositional analysis of lunar and planetary soils	Lyon, R.J.P.	SRI						X
NASr-82 (Moore) Construction of a 60-inch lunar and planetary telescope	Kuiper, G.P.	U. of Ariz.	✓					X
NASr-138 (Moore) Development and flight testing of Mariner Photopolarimeter	Gehrels, A.M.J.	U. of Ariz.						X
NASr-185 (Gaugler) Studies of planetary atmosphere and lunar photography (balloon flights)	Roberts, W.O.	UCAR			X			✓
NASw-508 (Quimby) Hydrocarbon analysis as a means of detect- ing life in space	Meinschein, W.	Esso Res. & Engineering						✓ X

S U P P O R T I N G R E S E A R C H

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S P R P

A P A P F P B

Project Designation and Contacts	Investigators	Affiliations	A P A P F P B
NASw-612 (Gaugler/Brown) Study program with the objective of developing a new mathematical model of radar echo information content for radar mapping lunar or planetary surface properties	Jean, F.H.	Dikewood Corp.	X
NASw-698 (Gaugler) Theoretical study of the coupling between the solar wind and the exosphere	Scarf, F.L.	STL	X
NASw-704 (Easter/Gaugler) Determination of average surface temperature of Mars from radiative equilibrium considerations. Venus investigations will be devoted primarily to an evaluation of available information and analysis of existing models of the atmosphere.	Ohring, G.	GCA	X
NASw-790 (Easter/Barth) Continue development of millimeter wave scanning spectrometer.	Wertman, R.C. Blanchard, R.J. Wilmarth, R.W.	IT&T	X
NsG-56 (Allenby) Improve our knowledge of the geology, geochemistry, and geophysics of the moon	Brown, H.	CIT	X
NsG-57 (Bryson/Allenby) Research on tektites and meteorites, and radiation damage in related silicate materials. Study nature, distribution, composition, and properties of various metallic and non-metallic phases in the meteorites	Cohen, A.J. Massalski, T.B.	Mellon Inst.	X

S U P P O R T I N G R E S E A R C H

Project Designation and Contacts	Investigators	Affiliations	I					
			S	P	R	P	A	P
NsG-64 (Moore) Research program for the study of infra-red instrumentation for thermal photography of the moon	Menzel, D.H.	Harvard U.						X
NsG-69 (Roman/Ott) Design and construct television system for use with telescopes above the earth's atmosphere	Schwarzschild, M.	Princeton U.	X	✓				✓
NsG-142 (Moore/Weldon) Continual photographic patrol and study of the physical conditions of the moon and planets	Tombaugh, C.W.	N.Mex. St. U.						X
NsG-161 (Moore/Weldon) Selenodetic and physical studies of the lunar surface	Kuiper, G.P.	U. of Ariz.						X
NsG-192 (Easter/Allenby) Conduct research on methods of improving the sensitivity and reliability of gas chromatographs	Lipsky, S.R.	Yale U.		X				X
NsG-196 (Allenby) X-ray diffraction studies of lunar-like material	Hess, H.	Princeton U.						X
NsG-199 (Easter/Gaugler) Improve the sensitivity and reliability of the detection device involving the principle of gas chromatography	Lovelock, J.E.	U. of Houston		✓				X
NsG-213 (Gaugler) Study of the scattering properties of the moon and how these properties are related to its surface structure	Hale, W.L. Tice, T.E.	Ohio St. U.					✓	X

S U P P O R T I N G R E S E A R C H

VI-22

Project Designation and Contacts	Investigators	Affiliations	I					
			S	P	R	P	A	P
NsG-216 (Allenby)	MacDonald, G.J.F.	UCLA						
Theoretical calculations on the internal structure of the planets and the structure of their atmospheres								X
NsG-222 (Bryson)	Pinson, W.H.	MIT						
Research on tektites; determine amount of trace elements in tektites of the MIT meteorite collection								X
NsG-234 (Moore)	Reintjes, J.F.	MIT						
Design and development of flight radar for planetary investigations								X
NsG-246 (Bryson)	Hawkins, G.S.	Boston U.						
Study of lunar craters								X
NsG-256 (Allenby)	Wainerdi, R.E.	Texas A&M						
Investigate feasibility of, and design equipment capable of, performing neutron activation analysis of the lunar surface								X
NsG-269 (Holloway/Holmes)	Berkner, L.V.	GRCSW						
Fundamental research in earth and planetary sciences							X	✓

S U P P O R T I N G R E S E A R C H

Project Designation and Contacts	Investigators	Affiliations	I					
			S	P	A	P	P	B
NsG-282 (Bryson) Study of the minor and accessory constituents of stony meteorites in the Harvard meteorite collection	Fronzel, C.	Harvard U.						X
NsG-291 (Dubin/Moore) Systematic in-flight photography and subsequent recovery of meteorites	Whipple, F.L.	SAO	X				✓	X
NsG-303 (Gaugler) Develop reliable and ultra-sensitive magnetometers to make magnetic measurements of lunar rocks	Vacquier, V. Belshe, J.C.	UCSD						X
NsG-312 (Allenby) Theoretical studies of the internal constitution of the planets with emphasis on the Jovian planets	Wildt, R.	Yale U.						X
NsG-313 (Allenby) Investigate the isotopic chemistry of meteorites	Wetherill, G.	UCLA						X
NsG-314 (Allenby) Study the solid phases of noble gases and hydrogen, methane, ammonia, and CO ₂ at high pressures	Kennedy, G.C.	UCLA						X

S U P P O R T I N G R E S E A R C H

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A P A P F P B

Project Designation and Contacts	Investigators	Affiliations							
NsG-317 (Gaugler) Study of the petrography and composition of meteorites, and of the effects of shock waves on rock	Arrhenius, G.O.S.	UCSD						X	
NsG-319 (Allenby) Determine the relative abundances of eleven trace elements in various meteorites	Goles, G.G.	UCSD						X	
NsG-321 (Allenby) Study the interaction of meteorites and cosmic rays and consider the origin and history of meteorites	Arnold, J.R.	UCSD						X	
NsG-322 (Allenby) Determine cosmic abundance of elements	Suess, H.E.	UCSD						X	
NsG-323 (Allenby) Study the relative isotopic abundances of various elements in meteorites, extract and study the inert gases in meteorites, and determine meteorite ages	Urey, H.C.	UCSD							X

S U P P O R T I N G R E S E A R C H

VI-25

Project Designation and Contacts	Investigators	Affiliations	I					
			S	P	R	P	P	B
			A	P	A	P	P	B
NsG-329 (Easter) Radio propagation techniques for the study of planetary ionospheres and inter-planetary medium	Garriott, O.K.	Stanford U.	✓	X				✓
NsG-362 (Moore) Obtain transmission spectra of the sun through simulated atmospheres, comparison spectra of the planets, and reflection spectra of the sun from laboratory simulated polar cap crystals	Heyden, F.J.	Georgetown Univ. Obsv.			X			✓
NsG-366 (Allenby) Research program on the origin and age of meteorites	Anders, E.	U. of Chicago					X	
NsG-377 (Easter) Program of lunar and planetary research with radio and radar astronomy techniques	Eshelman, V.R.	Stanford U.	✓	X			X	
NsG-399 (Bryson) A program to improve the sample distribution program of the Nininger Meteorite Collection	Moore, C.B. Eyring, L.	Ariz. St. U.						X
NsG-400 (Bryson) Thermal gradient in planetary bodies	Clark, S.P. Jr.	Yale U.						X

S U P P O R T I N G R E S E A R C H

Project Designation and Contacts	Investigators	Affiliations	I					
			S	P	R	P	A	P
NsG-407 (Moore)								
Investigation of polarization character- istics of the decametric radiations from Jupiter	Smith, H.J. Douglas, J.N.	Yale U.						X
NsG-419 (Moore/Fellows)								
Electromagnetic investigation of planetary atmospheres	Barrett, A.H. Graham, J.W. Rafuse, R.P.	MIT						
NsG-426 (Gaugler)								
Research in selected fields of physics and astronomy and cosmic ray studies	Leighton, R.	CIT						
Development of prototype detectors for high latitude solar and galactic cosmic ray research	Vogt, R. Neher, H.U.					X		✓
NsG-432 (Moore)								
Research on millimeter wavelength radia- tion from solar bodies in support of solar system probes	Tolbert, C.W.	U. of Texas						
NsG-436 (Gaugler)								
Study gravitational radiation	Misner, C.W. Weber, J.	U. of Md.					✓	
								X

S U P P O R T I N G R E S E A R C H

VI-27

Project Designation and Contacts	Investigators	Affiliations	I					
			S	P	R	P	A	P
NsG-439 (Bryson) Quantitative investigation of the mineralogy and petrography of iron and stone meteorites	Cameron, E.N.	U. of Wisc.						X
NsG-451 (Moore) Establishment and operation of a western hemisphere planetary information center	Hall, J.S.	Lowell Obsv.						X
NsG-452 (Allenby) A flight instrument will be built capable of elemental analysis of the lunar surface utilizing inelastic neutron scattering	Mark, H.	U. of Calif. Berkeley						X
NsG-458 (Easter/Gaugler) Development of chemisorption detectors	Hoenig, S.A.	U. of Ariz.	X					✓
NsG-465 (Bryson) Study of Wells Creek Basin, Tenn. meteorite impact structure	Wilson, C.W. Stearns, R.G.	Vanderbilt U.						X
NsG-473 (Bryson) Structural and mineralogical study of meteorite impact craters	Tuttle, O.F.	Penn State U.						X
NsG-477 (Gaugler) Determine radar cross-section of specific areas of the earth at 1000 km	Moore, R.K.	U. of Kansas					✓	X

VI-28

TASKS	TECHNICAL MONITORS	I							
		A	P	A	P	P	P	P	B
Ames Research Center	Papazian, H. Study the chemical physics of formation of chemical complexes, free radicals, and their molecular constitution, in interplanetary space, on comets and on the planets as they are influenced by solar radiation, energetic particles, fields, elemental abundances and other environmental parameters.	X							✓
Goddard Space Flight Center	O'Keefe, J.A. Obtain a clearer insight of lunar and planetary surfaces and the composition of extraterrestrial material by studying the mechanism by which grooves and pits are formed on tektites, the study of micrometeorites from Antarctic ice and the study of lunar impactites if such impactites can be recovered.	X							✓
	Donn, B.D. Extend, by experimental and theoretical studies, the theory of crystal growth under astronomical conditions are related to interstellar and interplanetary grains. This will be followed by a laboratory study of the processes involved when condensed volatile matter is exposed to UV light and corpuscular radiation.	X							✓

SUPPORTING RESEARCH AT NASA CENTERS

VI-29

TASKS	TECHNICAL MONITORS	I							
		A	P	A	P	F	P	B	
Jet Propulsion Laboratory	Barath, F.							X	
Develop an instrument capable of space flight that can provide a high resolution thermal photograph of a planet's surface from a fly-by or orbiting spacecraft of the Voyager class.									
Measure the broadband RF emission characteristics of natural terrain materials in order to relate their radiometric properties to their composition and physical state.	Barath, F.							X	
Test and evaluate the 128 channel Loral pulse height analyzer. Develop a cabling system and power supply for the improved CR detector. Develop a new circuit for pulse shape discrimination of neutrons and gamma-rays in scintillation detectors. Continue limited participation in neutron activation investigation.	Margetts, D.							X	
Investigate techniques used on soft landing spacecraft in the acquisition and distribution of surface samples. Study effects of collection, distribution, and preparation techniques on the samples. Samples thus obtained will be compared to standard samples on laboratory instruments.	Thiele, C.							X	

SUPPORTING RESEARCH AT NASA CENTERS

TASKS	TECHNICAL MONITORS	I S P R P A P A P F P B									
Jet Propulsion Laboratory (Contd.)	Mackin, R.J. Jr.										
Experimental determination of the lunar neutron albedo which, while presumably greater than that of the earth is also subject to the same sort of time variations. Measurements conducted near the earth will enable one to estimate the importance of these variations in the lunar albedo, which is of interest because of its hydrogen sensitivity and because of the radiation hazard it represents to manned lunar exploration.										X	
Define problems of Mars for investigation by space-craft. Define geological problems of Venus.	Gray, F.B.									X	
Conduct experiments and studies on X-ray diffraction analysis to prove its capabilities as an important and rapid technique for determining the SiO ₂ content of glasses, rock, and minerals.	Gray, F.B.									X	
Make calculations on the thermal history of the earth, moon, and planets, and develop methods for lunar and planetary heat flow measurements using a heat flux meter.	Gray, F.B.										X

SUPPORTING RESEARCH AT NASA CENTERS

TASKS	TECHNICAL MONITORS	I S P R P A P A P F P B					
		A	P	A	P	F	P B
Jet Propulsion Laboratory (Contd.)							
Define the problems of the lunar surface and determine optimum methods for solutions of these problems.	Gray, F.B.						X
Conduct petrologic studies designed to further our understanding of the development of silicate systems under various environments and to relate these results with possible planetary models. Also, suggest methods of petrologic analysis which may be applicable to spacecraft operations.	Gray, F.B.						X
Develop a neutron activation analysis system for the determination of planetary and lunar surface composition.	Gray, F.B.						X
Engage in feasibility and design studies of dispersive and non-dispersive scanning and fixed, electron and fluorescence excited X-ray systems with a view to developing new approaches to instrumentation designed to perform remote elemental and possible mineralogical analysis and thus produce a unit worthy of inclusion in a planetary or lunar landing payload.	Gray, F.B.						X
Fabrication and flight of a gamma ray spectrometer to detect natural and induced lunar radioactivities to throw light on the composition, heat balance, and history of the moon.	Gray, F.B.						X

SUPPORTING RESEARCH AT NASA CENTERS

TASKS	TECHNICAL MONITORS	I									
		A	P	A	P	F	P	F	P	B	
Jet Propulsion Laboratory (Contd.)											
Develop an interferometer spectrometer of rapid scan capability (20 sec.) which is suitable for Mars 66-69 mission.	LaPorte, D.D.	X							✓		
Develop gas chromatograph technology in the direction of low-volume, lightweight instrumentation suitable for Voyager planetary entry capsules. Investigations will be directed toward both atmospheric and organic systems.	Josias, C.								X		
Develop a flight mass spectrometer that will be capable of measuring the composition at the extremely low pressures found in the lunar atmosphere, solar wind, deep space, and possibly comet tails.	Gray, F.B.	X									
Design, construct, test and evaluate a scientific breadboard model of a fixed grating, multiple detector IR spectrometer. Demonstrate feasibility of using this instrument for making temperature soundings in atmospheres and determining the existence of biology on planet surfaces from emission spectra.	Thiele, C.								✓		
		X								X	X

VI-33

TASKS	TECHNICAL MONITORS	A	S	P	R	I
Jet Propulsion Laboratory (Contd.)						
Extend our knowledge of the moon and the planets through ground-based observation and measurements.						
Determine the compositions, thermal structures and velocity fields in planetary atmospheres, and acquire knowledge on the characteristics of the lunar surface, using Coude focus spectrometers.	Gray, F.B.	X	✓		✓	
Investigate new techniques in gas chromatography technology. These investigations will be focused on the following areas: study of new column designs, study of new detectors, study of sample handling techniques, and advanced chromatograph systems.	Thiele, C.					X

BIOSCIENCE

The availability of transportation equipment which allows escape from terrestrial influence offers an unprecedented opportunity to study the role of earth environmental parameters on the fundamental processes of living organisms and systems. Since the adaptation to environment by genetic, physiologic, or other processes constitutes one of the most significant characteristics of successfully surviving organisms, we are confronted with an opportunity to test the validity of numerous biological hypotheses. A series of experiments can now be carried out in those basic areas of bio-adaptation which present themselves as the foci of modern theoretical biology.

BIOSATELLITE PROJECT:

The spacecraft capsule is maintained at a temperature of $75 \pm 5^{\circ}$ F and 40 to 60% relative humidity for the primate and $75 \pm 2^{\circ}$ F with 40 to 70% humidity for the radiation experiments on plants and animals or the biological rhythms and cellular processes experiments. Longitudinal accelerations up to 20 g and temperatures inside the capsule of up to 100° F may be experienced during re-entry. During spin-up for stabilization prior to orbital injection or prior to retro-rocket firing, the rotational velocity of the spacecraft will be approximately 100 RPM. The gravity force in orbit will be maintained, through attitude control, to be less than 10^{-5} g for 95% of the time in orbit and always less than 10^{-4} g. The maximum allowable deceleration that the experiments can be subjected to upon impact is 60 g. The radiation will be provided by a radioactive source of not over 1 Curie with shielding to limit the radiation. Natural radiation will be limited to 2 roentgens per day by the orbital altitude selected.

The Biosatellite Project consists of six flights in space to determine the biological effects on plants and animals of weightlessness, radiation and the absence of a diurnal cycle. The first flight is planned for late in 1965 and

subsequent flights are scheduled at 3-month intervals. The satellite will be boosted into a 200 nautical mile circular orbit inclined at about $28\frac{1}{2}$ to $33\frac{1}{2}^{\circ}$ to the equator by a Thor Delta or a Thrust Augmented Thor-Delta vehicle. Orbit durations of from 3 to 30 days are planned. The spacecraft will weigh from 1000 to 1300 pounds, and will have a payload capacity of 2 to 5 cubic feet and 150 to 200 pounds. All satellites will be recoverable.

The re-entry vehicle and an adapter comprise the spacecraft. The re-entry vehicle is a scaled-up Discoverer satellite in the shape of a truncated cone with a maximum diameter of 40 inches and a length of about 33 inches. The experiments are contained in the re-entry vehicle along with the heat shield and recovery system (parachute and recovery aids) while the adapter contains all of the equipment not necessary for de-orbit re-entry and recovery. The adapter is a conical and cylindrical section from 40 inches to 52 inches in diameter and about 44 inches long.

BEHAVIORAL BIOLOGY

The behavior of organisms occupies a central position in biological theory. Of primary interest to biological science is the generality of the Darwinian theory of evolution through natural selection of random hereditary fluctuations. The concept of natural selection, central to this theory, is to a large extent based upon the capacity for behavioral adaptation. Concurrent with evolutionary changes in structure come alterations in behavioral capacities which, in turn, are determinants of survival through selection. Thus, behavior participates directly in this cycle of events through both individual and social adaptation.

It should be emphasized, however, that behavior evolves along two axes. Selective reinforcement of adaptive responses, through which the individual organism acquires a repertoire of responses which are reinforced by the consequences they produce, proceeds in much the same manner as does phylogenetic evolution. Contemporary thinking in behavioral science has been dominated by this central

concept, and the essential role of reinforcement in the control and manipulation of behavior has been impressively demonstrated. Whether termed "information storage and retrieval," "learning and memory," or more empirically, "the effects of reinforcements on response probability," studies designed to provide a full understanding of the manner in which the human brain handles information, and the development of methods for maximizing its efficiency, are an obvious necessity for extended space voyages of the future. The development of behavioral techniques which possess a high degree of precision, sensitivity, and reliability for the control and manipulation of behavior, combined with recent advances in neurophysiological and biochemical techniques, and new concepts of behavior pattern formation and localization at the molecular level, make imminent the solution of a variety of problems related to the biological bases of behavior.

Problems concerned with information processing, storage, and retrieval overlap conceptually with problems of communication, which involve research on the principles of inter- and intra-species communication of intelligent information, emotional status and basic drives. As technological progress is made, basic knowledge of communication processes becomes increasingly important, as does the integration and utilization of these advances with the behavioral and biological sciences. The utilization of "cybernetic" models has only begun to provide the conceptual basis for examining complex bio-behavioral systems, although their implications for the study of man-machine systems have long been recognized. The use of computers provide not only the basis for understanding complicated systems such as the brain, but also provide models for their conceptual analysis. Understanding the mathematical requirements for information transmission in communication systems holds promise for the development of mathematical models necessary for the theoretical understanding and prediction of behavior.

A further matter of concern is the orientation of biological organisms in time and space in the absence of

terrestrial cues, including the mechanisms of internal clocks, their synchronization with environmental stimuli and their modifiability through conditioning. This interest logically extends to a concern for the behavioral effects observed in man as a function of diurnal cycles and other innate and acquired cyclic functions and their correlation with time. Hence, while emphasizing a basic approach to the study of bio-behavioral phenomena, the potential this approach holds for the solution of problems concerned with man's survival and performance in space is not underestimated.

EXO BIOLOGY

The clearcut identification of life on other planets is a matter of major importance to our understanding of the universe, or at least the solar system, from a biological point of view. For hundreds of years man has awaited confirmation of theories regarding the separate origins of life on different planets and how this may relate to the origin of life on earth. The search for and study of extraterrestrial life remains as one of the greater challenges of the space age.

Ground-based studies on the origin of life and in-flight experiments will be conducted to identify and study extraterrestrial life. It is planned to determine the types of analyses essential for the identification of extraterrestrial life and related substances. Prototype instrumentation will be developed, including vidicon microscope, gas chromatograph, infrared spectrophotometer, radioactive CO₂ analyzer, mass spectrometer, optical rotation, and other organic compound and life detection apparatus. Exotic environment simulation chambers are needed as well as methods equipment and components for decontamination of vehicles and payloads. This includes the development of heat resistant componentry that is, resistant to time-temperature cycles essential to kill all bacterial spores.

The funding and development of centers is planned chiefly in academic environments, where broad and interdisciplinary research can be conducted in the exploration of space from the exobiological and cosmobiological point of

view. The establishment of such centers would hinge largely on available laboratory space and on-board staff members with recognized competence and interest in specialized relevant disciplines as well as the overall subject of this specific program.

Microbial analysis of the upper atmosphere was launched primarily because of the great interest of the biological community in the quantity, distribution and nature of organisms in the stratosphere and because existing data are limited and unreliable. Although most scientists do not take the theory of panspermia seriously, for those who do, this program would obviously throw some light on the question, particularly if a means of sampling in space itself could be perfected.

A program of meteorite collection and analysis includes the application of various methods of increasing available meteorite material of the carbonaceous chondrite type for chemical and biological analysis. At the present time there are only 19 meteorites in this class in existence. Most of these are either very small, contaminated, in Russia, or tied up by curators in museums. Analysis of the now limited material is being conducted under NASA support by Meinschein, Calvin, and the Ames Research Center. New "finds" would go to these and other experienced groups.

In the area of sterilization of spacecraft the aim is to develop methods and procedures for reducing the number of bacteria to the best minimum on lunar and Venus probes and for actually sterilizing capsules destined for Martian landing. The techniques developed must permit optimum performance of the instrument payload and must produce no decrement in the overall reliability of the mission.

Infrared spectroscopic studies of the planets are made to obtain information of biological significance such as the presence of CO_2 , CH_4 , and C=O , C=N , NH_2 , CO , oxides of nitrogen, water vapor, and, of course, a confirmation or lack thereof of the classical observations of Sinton interpreted as an accumulation of hydrocarbonous materials in

the dark areas of Mars. Instrumentation may be ground-based, balloon-launched, carried on a planetary fly-by, etc., with certain advantages and limitations in each case.

In the design, development and testing of life detection equipment consideration will be given to numerous remote instrument approaches for demonstrating the presence of life or life related substances on extraterrestrial bodies. The devices are designed to provide one or more sensors with metabolic, physical, chemical, or morphological facts which are presented to receiving stations on the earth by telemetry as interpretable data for study of extraterrestrial life.

The program in evolutionary and theoretical biology includes a wide variety of investigations relating to the origin of life, molecular evolution, the development of significant steps in early evolution of planets and animals, symbiosis, cellular biochemistry, nature and mechanisms of cell replication, chemistry of terrestrial sediments, paleo-biochemistry, and refinement of methods for detection and study of biological substances and residues.

PHYSICAL BIOLOGY

In the area of physiology and bio-mechanics, support is available for ground-based and applied research into mechanisms and principles of systemic physiology (cardio-vascular, respiratory and neurophysiology) and general physiology of living organisms, systems and processes. Studies include the effects of (individual and synergistic) and control of, physiological stresses, including vibration, noise, spin, weightlessness, environmental extremes, radiation and acceleration.

Metabolic alterations in terms of energy exchange and heat transfer incident to exposure to prolonged dynamic physiologic and psychologic stresses are significant to the space biologist. This area includes nutritional studies in terms of basic requirements, both physiological and psychological, for prolonged space travel. Information is required on the

types and range of nutrients needed for minimal existence and full efficiency. Different and varying diets and methods for synthesizing diets and effects of diets over long periods of time are also being investigated.

Research and development are conducted for acquiring new, reliable and sophisticated instruments to measure and analyze standard and classical biological, biochemical, biophysical, biopsychological and physiological parameters and for producing methods for acquiring biological data which have hitherto been unattainable. Refinement in reliability of existing instruments is also being pursued. Development and research into newer methods and use of biological data, processing, storage, and analysis.

In the area of biophysics research is supported to describe biological systems at molecular and cellular levels. Studies are directed towards the understanding and quantitative description of vital cellular processes including biosynthesis of molecular species. Chemical transformations and metabolic mechanisms that provide energy for maintenance and activity of protoplasmic structures, regulation of the local physical and chemical environment, enzyme activities and the intra-cellular aspects of radiation and effects of gravitational fields, will be investigated.

ENVIRONMENTAL BIOLOGY

The outer space environment offers a unique opportunity to study the basic properties and nature of living earth organisms with new tools previously unavailable. The new components of the space environment of biological importance are decreased gravity and weightlessness, the imposition of an environment unequivocally disconnected from the earth's rotation, and radiation fluxes and energies unmatched by anything produced artificially on earth. There is still so much ignorance of biological organization and so little acceptable theory, that we are more likely to encounter unexpected results, to detect unanticipated relationships, and to be surprised by the behavior of biological systems

to the unique aspects of the space environment, than is the case for non-biological systems. In addition to providing data of fundamental value in biological science, the studies will delineate hazards to astronauts, and determine and define effects on degradation of human performance. To study the effects of these factors it is necessary to use orbiting spacecraft. Highest priority of space studies will be on the effects of decreased gravity and weightlessness, and cosmic radiation, especially high energy heavy particles. Studies will also include effects of the entire electromagnetic spectrum, radiation from solar flares and trapped radiation, hard vacuum altered magnetism, and other exotic environmental factors on various forms of terrestrial plant and animal life and their rhythms.

Environmental biology includes the study of the effects of simulated lunar and planetary environments on living earth organisms. Plants and animals (including anaerobes and chemoautotrophs) from extreme ecological environments such as dry tundra, mountain tops, thermal springs, and high CO₂ habitats such as volcanoes are being studied under simulated planetary conditions. Organisms are also being developed by genetic selection to survive simulated planetary environments.

Research is also being carried out on biological organisms for application and exploitation in space, such as, (a) use of organisms in space vehicles, space stations, planetary greenhouses, e.g., closed ecological systems, and food supply, (b) use of test organisms on other planets and space stations to determine presence and effects of lethal radiation, harmful biological organisms or substances, and other exotic environmental factors, (c) use of plants for modification of planetary atmospheres, (e.g., greenhouse effect), (d) use of specialized morphological and physiological adaptations, (e.g., hibernators for space travel), and (e) use or exploitation of life on other planets.

S U P P O R T I N G R E S E A R C H

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S P R P
A P A P F P B

Project Designation and Contacts	Investigators	Affiliations	A P A P F P B
R-39 (Jenkins/Young) Research on the effects of very strong magnetic fields and of magnetic field free environments on man and animals	Beischer, D.E.	US Naval Sch. of Aviation Med.	X
R-46 (Jenkins/Young) Determine the effects of continuous three-dimensional rotation of the earth's gravitational, magnetic, and electrical field gradients on plant morphogenesis	Gordon, S.A.	US AEC	X
R-60 (Jenkins) Conduct research directed toward the development of biopaks and experiments for use in a space environment	Hollaender, A.	Oak Ridge Natl. Lab.	X
R-99 (Jenkins) Investigation of ecologic relationships between bacteria and algae in photo-synthetic gas exchangers	Moyer, J.E. Ward, C.H.	USAF Aero-space Med. Lab.	X
NASr-10 (Quimby) Develop a radioisotopic biochemical probe for extraterrestrial life	Levin, G. Horowitz, N.	Resources Research Inc.	X

S U P P O R T I N G R E S E A R C HI
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A P A P F P B

Project Designation and Contacts	Investigators	Affiliations	A P A P F P B
NASr-11 (Jenkins) Development of biosatellite experiment to study the effect of weightlessness on respiration and photosynthesis of algae	Brown, A.H.	U. of Minn.	X
NASr-22 (Jenkins) Viability of organisms in Martian atmosphere	Hawrylewicz, E.J. Ehrlich, R.	Armour Research Foundation	X
NASr-49 (11) (Jacobs) Study the characterization of photo-chemically active extract to chloroplasts, define the components required in the photo-active system, and learn the role of each of the energy transfer processes.	Graham, B.	SRI	X
NASr-49 (16) (Jacobs) Investigate the magnetic susceptibility of selected pure organic compounds and correlate measurements made with structure, physical and chemical properties of the compounds investigated.	Vaile, R.B.	Stanford Res. Institute	X
NASr-146 (Jacobs) Bioinstrumentation for circadian rhythms study (hamsters and drosophila)	Goodman, R.	Franklin Inst.	X
NASr-159 (Quimby) Design and construction of an improved optical microscope system for biological research	Allen, R.D.	Princeton U.	X

S U P P O R T I N G R E S E A R C H

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S P R P
A P A P F P B

Project Designation and Contacts	Investigators	Affiliations	A	P	A	P	F	P	B
NASr-169 (Jacobs) Extend usefulness of cytogenic methodology Wald, N. as a research technique and as a bio- medical monitoring procedure through the utilization of automatic electronic scan- ning and computer analysis of chromosomes		U. of Pitts- burgh							X
NASw-508 (Quimby) Hydrocarbon analysis as a means of de- tecting life in space	Meinschein, W.	Esso Res. & Engineering						✓	X
NASw-517 (Jacobs) Develop superior diet for man in space	Rosenthal, N.A.	Schwarz Bio- research Inc.							X
NASw-542 (Jacobs/Menzel) Develop molecular electronic implant stimulator monitor system for behavioral pattern studies	Preston, R.	United Air- craft Corp. Systems							X
NASw-557 (Quimby) Determine the feasibility of detecting extraterrestrial life by means of rotatory dispersion profile of pure DNA	Blei, I.	Melpar Inc.							X
NASw-571 (Quimby) Research on detection of extraterrestrial life by UV spectrophotometry	Blei, I.	Melpar Inc.							X

Project Designation and Contacts	Investigators	Affiliations	A	P	A	P	F	P	B
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NsG-69 (Roman/Ott)

Design and construct television system for Schwarzschild, M. Princeton U.
use with telescopes above the earth's
atmosphere

NsG-70 (Jenkins)

Investigation of phycophysiology in controlled environments

Krauss, R.W.

U. of Md.

NsG-80 (Jenkins)

Study treatment of human wastes by use of biological organisms and to convert wastes into useable material for algae

Tischer, R.G.

Miss. St. U.

NsG-81 (Quimby)

Conduct research, design and test a device ("multivator") comprising a variety of reagents, for detection of the presence of microbes. Also, cytochemical studies of planetary microorganisms

Lederberg, J.

Stanford U.

NSG-101 (Quimby)

Studies on reflection spectra, meteorite analysis, and chemical evolution

Calvin, M.

U. of Calif.
Berkeley

NsG-126 (Jenkins)

Experimental and theoretical studies of the growth and biochemical activities of terrestrial microorganisms in simulated planetary environments

Silver, S.

U. of Calif.
Berkeley

S U P P O R T I N G R E S E A R C H

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S P R P

<u>Project Designation and Contacts</u>	<u>Investigators</u>	<u>Affiliations</u>	<u>A P A P F P B</u>
NsG-173 (Quimby) Space Bioscience Institute	Fox, S.	Fla. St. U.	X
NsG-208 (Quimby) Studies on extremely small self-replicating systems	Morowitz, H.	Yale U.	X
NsG-210 (Jenkins/Young) Research on influence of gravity on unicellular organisms, and optimization of a UV flying spot microscope for living cell observations	Montgomery, P.O'B.	U. of Texas	X
NsG-211 (Quimby) Detection and identification of organic matter by mass spectrometry	Biemann, K.	MIT	X
NsG-218 (Quimby) Produce and study "probiological systems" or precellular chemical systems incapable of reproduction but which may carry out complex metabolism	Blois, S. Pattee, H.	Stanford U.	X
NsG-226 (Quimby) Synthesis of porphine-like substances from simple precursors under primeval conditions	Szutka, A.	U. of Detroit	X

S U P P O R T I N G R E S E A R C H

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S P R P
A P A P F P B

VII-14

Project Designation and Contacts	Investigators	Affiliations	A P A P F P B
NsG-230 (Quimby) Development of microspectrophotometric instrumentation for the study of pigments and organic molecules within living cells	Wolken, J.	U. of Pittsburgh	X
NsG-231 (Jenkins) Investigation of the effects of plant growth hormones on plant development in the absence of gravitational effects	Lyon, C.J.	Dartmouth College	X
NsG-257 (Quimby) Synthesize purines and pyrimidines under possible primitive earth conditions	Oro, J.	U. of Houston	X
NsG-259 (Jacobs) Experimental investigation of human circadian rhythms, including consideration of natural and artificial Zeitgeber	Aschoff, J.	Max-Planck Inst., Germany	X
NsG-271 (Jenkins) Physiological effects of weightlessness and space radiations on hibernators	Musacchia, X.J.	St. Louis U.	X
NsG-278 (Belleville/Reynolds) Develop the steps necessary for the realization of interspecies communication and attempt to find the most probable fertile means of such communication	Lilly, J.C.	Communications Res. Inst.	X
NsG-285 (Jacobs) Individualized chemically defined diets in life support systems during space flight	Winitz, M.	City of Hope Medical Center	X

S U P P O R T I N G R E S E A R C H

Project Designation and Contacts	Investigators	Affiliations	I					
			S	P	R	P	A	P
NsG-291 (Dubin/Moore) Systematic in-flight photography and subsequent recovery of meteorites	Whipple, F.L.	SAO	X				✓ X	
NsG-295 (Jacobs) Investigate biological effect of chronic exposure to artificial atmospheres	Hiatt, E.P.	Ohio St. U.					X	
NsG-324 (Jacobs) Physics of cellular synthesis, growth and division	Pollard, E.C.	Penn St. U.					X	
NsG-335 (Quimby) Research on molecular biology of nitrogen fixing nodules in common legumes	Thorogood, E.	U. of Pa.					X	
NsG-341 (Quimby/Young) Detailed analysis of the organic and inorganic components of carbonaceous and other stony meteorites to explore further the possibility of life processes on the parent bodies. Also the organic microstructures in carbonaceous chondrites will also be studied.	Nagy, B. Hennessy, D.J. Claus, G.	Fordham U.					X	
NsG-347 (Quimby) Investigation of the biochemistry of meteorites, with emphasis on the hydrocarbon and sulfur constituents	Kaplan, I.R.	CIT					X	
NsG-374 (Belleville) Combined program of neurophysiological research and training	Galambos, R. Higgins, E.	Yale U.					X	
NsG-375 (Quimby) Comparative study of the evaluation of enzymes and nucleic acids	Kaplan, J. Levine, L. Marmur, J.	Brandeis U.					X	

S U P P O R T I N G R E S E A R C H

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S P R P

VII-16

Project Designation and Contacts	Investigators	Affiliations	A P A P F P B
NsG-396 (Belleville) Study of temporal factors controlling animal activity, including consideration of the extent to which natural rhythms may be changed	Bolles, R.C.	Hollins College	X
NsG-433 (Belleville) Investigation of the role of experience in the etiology of animal and human physiological and behavioral responses to situational stress in later life	Henry, J.P. Meehan, J.P.	U. of S. Calif.	X
NsG-437 (Belleville) Experimental studies of reinforcing brain stimulation, including consideration of behavioral consequences	Valenstein, E.S.	Fels Res. Inst.	X
NsG-440 (Jenkins) Experimental investigation of skeletal mineral losses in humans and pigtail monkeys during immobilization	Mack, P.B.	Texas Woman's U.	X
NsG-441 (Jacobs) Investigations in space-related molecular biology, including consideration of the molecular organization of extraterrestrial matter	Fernandez-Moran, H.	U. of Chicago	X
NsG-446 (Belleville) Research contributing to our knowledge of monitoring behavior through the development of basic information on the nature and interactions of major independent variables	Clark, F.C.	Assoc. for Advanced Mental Health	X
NsG-456 (Belleville) Experimental investigation of gravity level preference in small animals	Lange, K.O.	U. of Kentucky	X

S U P P O R T I N G R E S E A R C H

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S P R P

Project Designation and Contacts	Investigators	Affiliations	A P A P F P B
NsG-457 (Jacobs) Symposium on cytogenetics of cells in culture, including radiation studies	Pomerat, C.M.	Pasadena Foundation for Medical Research	X
NsG-459 (Jenkins) Study effects of environmental extremes on mammals, particularly cold temperatures	Morrison, P.	U. of Alaska	X
NsG-462 (Belleville) Partial support of multidisciplinary studies in the neurosciences	Schmitt, F.O.	MIT	X
NsG-464 (Jenkins) Study the effects of low pressures on cellular ultrastructure and cytochemistry in plants	Mozingo, H.N.	U. of Nevada	X
NsG-470 (Belleville) Experimental analysis of circadian rhythms under terrestrial conditions, including techniques for studying rhythms in an orbiting satellite	Pittendrigh, C.S.	Princeton U.	X
NsG-479 (Quimby) Research oriented toward the increase of understanding of biology through the study of living chemical structures	Jones, H.	U. of Calif. Berkeley	X
NsG-485 (Bolton) Studies in scientific communication research using space-related biology as the subject area	Shilling, C.W.	George Washing- ton Univ.	X

S U P P O R T I N G R E S E A R C H

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S P R P

Project Designation and Contacts	Investigators	Affiliations	A P A P F P B
NsG-510 (Jacobs) Experimental investigation of the basic dietary requirements of man with emphasis on water-soluble, chemically-defined diets	Winitz, M.	Medical Science Research Founda- tion	X

SUPPORTING RESEARCH AT NASA CENTERS

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S P R P
A P A P F P B

TECHNICAL
MONITORS

TASKS

Ames Research Center

Investigate the utilization of nitrogen in the metabolic pathway of a phytochemical system.

Yokoyama, K.

X

Synthesize protein molecules and other compounds of biological interest by using thermal copolymerization of amino acids. Chromatography and mass spectroscopy will be used to analyze the end products.

Young, R.S.

X

Design improved methods for making macroscopic membranes from organic molecules found in natural cell membranes, and study their properties in the widest possible range.

Trurnit, H.

X

Conduct a comparative study of genetic systems, how they are replicated and how they store and transmit their information.

Painter, R.

X

Determine the effects of intense visible light, and ultraviolet light on the photosynthesis and loss of cellular components by photosynthetic organisms. Determine environmental extremes (terrestrial and extraterrestrial) suitable for photosynthesis. Determine possible mechanisms of origin of photosynthetic systems

Zill, L.

X

SUPPORTING RESEARCH AT NASA CENTERS

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S P R P
A P A P F P B

TASKS

TECHNICAL
MONITORS

Ames Research Center (Contd.)

Isolate and chemically characterize the lipid components of organelles which carry on the photosynthesis process; determine the chemical and physical properties of these lipids as a basis for their involvement in the structures observed in chloroplasts by electron microscopy, and determine the enzymic mechanisms responsible for the anabolic and catabolic reactions of these lipids and their possible participation directly in the photosynthesis process.

X

Study the structure of ribonucleic (RNA) and desoxyribonucleic acids (DNA). Certain features of the structure will be probed by the selective use of specific enzymes involved in the metabolism of nucleic acids.

X

To demonstrate virus production in certain types of living cells attempts will be made to concentrate and purify the enzymes involved in the synthesis of these products.

X

Conduct exploratory experiments on the effects of prolonged exposure to rotation and acceleration on behavioral functions of infra-human organisms.

X

Frommhangen, L.

Frommhangen, L.

Weissman, N.

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S P R P
A P A P F

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SUPPORTING RESEARCH AT NASA CENTERS



TECHNICAL MONITORS

SPRP
APFP

TASKS

A P A P F P B

Ames Research Center (Contd.)

Study, in monkeys and rats, the microelectrode recording of nerve cell and astroglial activity; and permeability to protein and fluorescent dyes and radioisotopic transport.

X

Determine, with simple organisms, the effects of particulate radiation pertinent to Biosatellite experimentation, survival of microorganisms in a lunar environment and genetic changes in interplanetary space flight and determine environmental factors which influence radiation-induced mitotic delay in unicellular organisms.

X

Adapt a variety of animals to an altered G environment by prolonged centrifugation. Study the physiology of metabolism of this adaptation both in a positive as well as in a negative G-loading direction.

X

Establish the natural period for certain free running endodiurnal cycles by exposing birds to a constant light environment.

✕

SUPPORTING RESEARCH AT NASA CENTERS

TASKS	TECHNICAL MONITORS	I S P R P A P A P F P B									
Ames Research Center (Contd.)											
Determine whether the stresses imposed by space voyages on experimental animals have an effect upon the synthetic metabolism activity of isolated organs and tissues and upon the total body metabolism of attacked animals.											X
Search for new methods for the detection of radiation injury before damage is visible morphologically. This will be combined with specialized radiation of the central nervous system.	Miguel, J. et al										X
Simulate the environments of planets of interest (Mars and Venus) and study the effects of such environments on survival, adaptation, metabolism and growth of microorganisms such as bacteria, fungi, lichens and algae from extreme environmental conditions.	Young, R.S.										X
Study the mechanism by which obligate halophilic bacteria grow in environments containing salt concentrations which prove hostile to more familiar forms of life.	Hochstein, L.										X
Examine the type of organic synthesis which can take place in the atmosphere of Jupiter.	Ponnamperuma, C.A.										X

SUPPORTING RESEARCH AT NASA CENTERS

TASKS	TECHNICAL MONITORS	I S P R P A P A P F P B									
Ames Research Center (Contd.)											
Study the synthesis of molecules of biological significance on primitive earth conditions and study the possible pathways that may have led to the origin of life on earth.	Ponnamperuma, C.A.									X	
Find an explanation for the existence of optical activity in molecules found in living systems.	Ponnamperuma, C.A.									X	
Determine the mode of synthesis of mitochondria in yeast cells.	Klein, H.P.									X	
Elucidate the mechanisms by which bacteria shadow their cellular reserve materials into the formation of new products.	Klein, H.P.									X	
Study the mechanism by which oxygen is incorporated into heterocyclic compounds and ascertain how widespread biologically is the heterocyclic mode of hydroxylation.	Hochstein, L.									X	
Conduct research leading to the design of suitable life detection apparatus for possible use on space vehicles.	Klein, H.P.										X

SUPPORTING RESEARCH AT NASA CENTERS

TASKS	TECHNICAL MONITORS	I S P R P A P A P F P B					
		A	P	A	P	F	P B
Jet Propulsion Laboratory (Contd.)	Ford, H.						X
Develop reliable analytical methods for the determination of viable microorganisms within materials and on surfaces of spacecraft components which have been exposed to a sterilization procedure.	Shipley, W.						X
Evaluate and select biological filters or filter materials that are capable of sterilizing fluids and gases which will be used on planetary spacecraft. Test methods will be both biological and physical. Select or develop a physical test method which will be reliable for indicating microbial retentive efficiency of filters.	Coon, K.						X
Develop physical and/or chemical test methods which will indicate that proper sterilization conditions have been attained in the environment being treated. Methods would be directed primarily towards dry heat and ethylene oxide mixture sterilization procedures.	Coon, K.						X

SUPPORTING RESEARCH AT NASA CENTERS

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S P R P
A P A P F P B

TASKS

TECHNICAL MONITORS

Jet Propulsion Laboratory (Contd.)

Study the composition and properties of the compounds Ford, H. which are in the only extraterrestrial organic matter now available. Characterization of the organic moiety in these meteorites in the realm of their synthesis within the solar system and in comparison with their terrestrial counterparts.

Advance the state-of-the-art in soil properties instrumentation.

Thiele, C.

Maintain cognizance of development of Lederberg's Multivator System.

Ford, H.

Develop a biological microscope to be used for the detection or identification of extraterrestrial life.

Ford, H.

Investigate the engineering problems of lightweight sample collection systems for planetary capsule missions; and of measuring ph, conductivity, optical illumination filtering and detection, and other life detection techniques. Provide engineering support in the formulation of exobiological experiments for Voyager.

Stuart, J.

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X

X

X

X

X

SUPPORTING RESEARCH AT NASA CENTERS

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I

S P R P

A P A P F P B

TECHNICAL
MONITORS

TASKS

Jet Propulsion Laboratory (Contd.)

Study refinements of fluorometric analysis of nucleic acids, proteins, and pigments of soil organisms in soil. Develop fluorometric methods for carbohydrates, polycarboxylic acids and other compounds involved in photosynthesis and respiration. Develop fluorometric methods for enzymatic reactions occurring in photosynthesis and respiration of soil microorganisms in soil suspension.

Ford, H.

X

Determine the response of controlled soil ecosystems consisting of defined soils, particularly with reference to response and activity of indigenous microorganisms to moisture.

Ford, H.

X

R E F E R E N C E S H E E T S

SATELLITES

PROJECT
DESIGNATION: Air Density/INJUN Explorers
(AD-A, AD/I-B, and AD/I-C)
Air Density Explorer

VEHICLE: Scout

DATE/SITE: 1Q64/PMR

TRAJECTORY: Apogee 3000 km, perigee 600 km
80° inclination

EXPECTED
LIFETIME: 12-18 months

HEADQUARTERS
CONTACT: R. Miller
Alternate: J. Freeman

EXPERIMENTER: W. O'Sullivan
C. Coffee
G. Keating

CONTRACTOR/
AGENCY: Langley Research Center

PARAMETER: Change in orbital elements

EXPERIMENT: Determine systematic changes of air
density as a function of altitude,
latitude, and time of day by drag on
a low density sphere.

TECHNIQUE: Derivation of drag data from changes in
orbit of 12 foot diameter low density
sphere and calculation of air density.

INSTRUMENT: Passive 12 ft. diameter low density
sphere with ground tracking

DISCIPLINE: Planetary Atmospheres

SATELLITES

PROJECT

DESIGNATION: AD-A, AD/I-B, AD/I-C (Air Density Explorer)
(Contd.)

EXPERIMENTER: L. Jacchia

CONTRACTOR/

AGENCY: Smithsonian Astrophysical Observatory

PARAMETER: Air density

EXPERIMENT: Determine non-systematic changes of the density of the upper atmosphere from studies of the drag on a low density sphere caused by short-term differences in solar activity.

TECHNIQUE: Derivation of drag data from short-term changes in orbit of 12 ft. sphere and calculation of air density.

INSTRUMENT: Passive 12 ft. diameter low density sphere with ground tracking

DISCIPLINE: Planetary Atmospheres

SATELLITES

PROJECT

DESIGNATION: AD/I-B, AD/I-C (Contd)
(INJUN Explorer)

EXPERIMENTER: J. Van Allen

CONTRACTOR/

AGENCY: State University of Iowa

PARAMETER: Energetic charged particles

EXPERIMENT: Measurement of downflux of corpuscular radiation with 16 detectors in the energy ranges between 0-22 Mev for electrons and between 0-40 Mev for protons to determine heating effects by the enhanced drag on the Air Density Explorer.

TECHNIQUE &
INSTRUMENT:

A variety of radiation detectors are to be employed including CdS energy flux detectors, CsI scintillators, 213, 303, and 112 Geiger-Mueller tubes and p-n junction detectors. The satellite is to be magnetically oriented with the various detectors pointing in various directions with respect to the magnetic field vector, thus allowing one to distinguish the dumped and trapped particles.

DISCIPLINE: Particles & Fields

SATELLITES

PROJECT

DESIGNATION: AD/I-B, AD/I-C (INJUN Explorer)
(Contd)

EXPERIMENTER: Rita Sagalyn

CONTRACTOR/

AGENCY: Air Force Cambridge Research Laboratory

PARAMETER: Low energy ions and electrons

EXPERIMENT: Determine the contribution of precipitating
low energy ions and electrons to the
heating of the upper atmosphere.

TECHNIQUE: Spherical retarding potential analyzer
to measure proton and electron energies
from 0-1.3 kev.

INSTRUMENT: Plasma probe

DISCIPLINE: Particles & Fields

SATELLITES

PROJECT
DESIGNATION: Energetic Particles Explorer - D (EPE-D)

VEHICLE: Thor-Delta

DATE/SITE: 2Q64/AMR

TRAJECTORY: Apogee 17,000 km, perigee 278 km
Inclination 18°

EXPECTED
LIFETIME: 1 year

HEADQUARTERS
CONTACT: E. Ehrlich
Alternate: J. Freeman

EXPERIMENTER: Walter L. Brown

CONTRACTOR/
AGENCY: Bell Telephone Laboratories

PARAMETER: Electron energy distribution

EXPERIMENT: Determination of the rough energy spectrum
in the artificial radiation belt.

TECHNIQUE: Diffused silicon p-n junction particle
detectors

INSTRUMENT: Diffused silicon p-n junction particle
detectors

DISCIPLINE: Particles & Fields

SATELLITES

PROJECT

DESIGNATION: EPE-D (Contd)

EXPERIMENTER: Carl McIlwain

CONTRACTOR/
AGENCY: University of California, San Diego

PARAMETER: Omnidirectional energetic particle flux

EXPERIMENT: Measurement of the omnidirectional intensity of electrons with energies greater than 3.5 Mev and of protons with energies greater than 35 Mev, using a spherical plastic scintillator of 1 centimeter diameter.

TECHNIQUE &
INSTRUMENT: Omnidirectional plastic scintillator

DISCIPLINE: Particles & Fields

EXPERIMENTER: Walter L. Brown

CONTRACTOR/
AGENCY: Bell Telephone Laboratories

PARAMETER: Angular distribution of electron flux in the artificial radiation belt.

EXPERIMENT: Two diffused silicon p-n junction particle detectors will be arranged to accept electrons directionally.

TECHNIQUE &
INSTRUMENT: Directional diffused silicon p-n junction particle detectors

DISCIPLINE: Particles & Fields

SATELLITES

PROJECT

DESIGNATION: EPE-D (Contd)

EXPERIMENTER: Carl McIlwain

CONTRACTOR/
AGENCY: University of California, San Diego

PARAMETER: Absolute intensity and angular distribution of electrons with energies greater than 0.5 and 0.8 Mev

EXPERIMENT: Directional detector employing a 0.1 inch diameter cylinder of plastic scintillator shielded to accept a cone of electrons of 15° half angle.

TECHNIQUE &
INSTRUMENT: Directional plastic scintillation counter

DISCIPLINE: Particles & Fields

EXPERIMENTER: L. R. Davis

CONTRACTOR/
AGENCY: Goddard Space Flight Center

PARAMETER: Ion-electron flux

EXPERIMENT: Measure particle fluxes, types, and energy of ions and electrons as functions of direction, time, and position in space relative to the Van Allen radiation belt.

TECHNIQUE &
INSTRUMENT: Scintillation counter with variable absorber wheel

DISCIPLINE: Particles & Fields

SATELLITES

PROJECT

DESIGNATION: EPE-D (Contd)

EXPERIMENTER: L. Cahill

CONTRACTOR/
AGENCY: University of New Hampshire

PARAMETER: Earth's magnetic field

EXPERIMENT: Measure the magnitude and direction of the earth's magnetic field between 1.7 and 3.5 earth radii by use of a two-axis saturable core magnetometer.

TECHNIQUE &
INSTRUMENT: Two-axis fluxgate magnetometer

DISCIPLINE: Particles & Fields

EXPERIMENTER: L. Slifer

CONTRACTOR/
AGENCY: Goddard Space Flight Center

PARAMETER: Solar cell damage

EXPERIMENT: Study of damage experienced by four units of differently protected solar cells of the N-on-p type which will be used because of the extensive measurements already made on these particular devices.

TECHNIQUE: The solar cells will present a voltage under solar illumination. The voltage will vary depending on the effects of radiation damage to the cells.

INSTRUMENT: N-on-P silicon solar cells

DISCIPLINE: Particles & Fields

SATELLITES

PROJECT
DESIGNATION: Atmosphere Explorer - B
(AE-B)

VEHICLE: Thor-Delta

DATE/SITE: 4Q64/AMR

ORBIT: Perigee 250 km; Apogee 900 km; maximum
inclination 85°

EXPECTED
LIFETIME: Six months

HEADQUARTERS
CONTACT: R. Horowitz
Alternate: E. Ehrlich

EXPERIMENTER: Larry H. Brace, GSFC

PARAMETER: Electron densities from approximately
 10^3 per c.c. to 4×10^6 per c.c.

EXPERIMENT: Measure distribution of electron tempera-
ture and density

TECHNIQUE: Langmuir probe method for determining
the distribution function of electrons
from analyses of the volt-ampere curve

INSTRUMENT: Swept voltage electron probe

DISCIPLINE: Ionospheres & Radio Physics (prime)
Planetary Atmospheres

SATELLITES

PROJECT

DESIGNATION: AE-B (Contd)

EXPERIMENTER: George P. Newton, GSFC
David R. Tauesch, GSFCPARAMETER: Atmospheric pressure from 10^{-6} to
 10^{-10} mmHg.EXPERIMENT: Measurement of atmospheric density,
pressure and temperature as a function
of altitude, time of day, geographic
location, and geophysical phenomena.TECHNIQUE: Direct measurement of atmospheric density
and pressure using suitable detectors
mounted on a spinning satellite.INSTRUMENT: Two Bayard-Alpert ionization gauges
Two Redhead ionization gaugesDISCIPLINE Planetary Atmospheres (prime;
Ionospheres & Radio Physics

SATELLITES

PROJECT

DESIGNATION:

AE-B (Contd)

EXPERIMENTER:

Carl Reber, GSFC.
James E. Cooley, GSFC

PARAMETER:

Neutral composition of the atmosphere
at masses 1, 4, 14, 16, 18, 28, and 32 AMU.

EXPERIMENT:

Measurement of partial densities of each
of the above noted masses as a function
of time of day, geographic location, and
geophysical phenomena. Gas kinetic tem-
peratures will be computed.

TECHNIQUE:

Direct measurement of the distribution
of the neutral gas species using a mass
spectrometer mounted on a spinning
satellite.

INSTRUMENT:

Double-focusing sector neutral gas mass
spectrometer

DISCIPLINE:

Planetary Atmospheres (prime)
Ionospheres & Radio Physics

SATELLITES

PROJECT
DESIGNATION: Ionosphere Explorers (IE-A & IE-B)

VEHICLE: Scout

DATE/SITE: 1Q64/PMR

ORBIT: Inclination, 80° ; Apogee, 1184 km;
Perigee, 800 km

EXPECTED
LIFETIME: 1 year

HEADQUARTERS
CONTACT: A. G. Opp
Alternate: M. J. Aucremanne

EXPERIMENTER: R. W. Knecht, Central Radio Propagation
Laboratory, National Bureau of Standards

PARAMETER: Electron density profile, approximately
300 to 1000 km. Cosmic noise level in
the 2 to 7 Mc frequency range. Electron
density in neighborhood of satellite.

EXPERIMENT: Measure electron density height profile
by pulse delay. Measure ambient noise
level. The experiment will map global
distribution and investigate this as a
function of time.

TECHNIQUE: Soundings of the ionosphere from above.
Group delay measurements on six fixed
frequencies, namely 1.50, 2.00, 2.85,
3.72, 5.47, 7.22 Mc/s.

INSTRUMENT: Ionosonde equipment of special design.

DISCIPLINE: Ionospheres & Radio Physics

SATELLITES

PROJECT

DESIGNATION: IE-A & IE-B (Contd.)

EXPERIMENTER: R. L. F. Boyd
A. P. WillmoreCONTRACTOR/
AGENCY: University College, LondonPARAMETER: Relative ion mass concentrations,
absolute ion densities, ion temperature

EXPERIMENT: ARIEL ion mass probe

TECHNIQUE &
INSTRUMENT: Mass spectrometry

DISCIPLINE: Ionospheres & Radio Physics

SATELLITES

PROJECT
DESIGNATION: Beacon Explorers (BE-A & BE-B)

VEHICLE: Scout

DATE/SITE: BE-A, 1Q64/PMR
BE-B, 2Q64/PMR

ORBIT: Inclination, $80^{\circ} \pm 2^{\circ}$; Apogee, 995 km;
Perigee, 846 km

EXPECTED
LIFETIME: 1 year

HEADQUARTERS
CONTACT: A. G. Opp
Alternate: M. J. Aucremanne

PARTICIPANTS: University of Illinois; Pennsylvania
State University; International participants;
National Bureau of Standards; Stanford
University

PARAMETER: Total electron content; absorption;
scintillation; possible addition of
local electron density probes (cylindrical)

EXPERIMENT: Provision of a multifrequency beacon,
enabling electron content and scintilla-
tions to be studied on a nearly global
basis.

TECHNIQUE: Ground-based measurements of Faraday
rotation, Doppler, and scintillations
using observations of beacon transmitters
carried by satellite.

INSTRUMENT: Beacon transmitters on frequencies of
20 Mc, 40 Mc, 41 Mc, 360 Mc plus Transit
frequencies of 162 Mc and 324 Mc

DISCIPLINE: Ionospheres & Radio Physics

SATELLITES

PROJECT

DESIGNATION: BE-A & BE-B (Contd)

EXPERIMENTER: Larry H. Brace, GSFC

PARAMETER: Electron densities from approximately 10^3 per c.c. to 4×10^6 per c. c.

EXPERIMENT: Measure distribution of electron temperature and density

TECHNIQUE: Langmuir probe method for determining the distribution function of electrons from analyses of the volt-ampere curve

INSTRUMENT: Swept voltage electron probe

DISCIPLINE: Ionospheres & Radio Physics (prime)
Planetary Atmospheres

SATELLITES

PROJECT
DESIGNATION: Interplanetary Explorers (IMP-A, IMP-B,
IMP-C)

VEHICLE: Thor-Delta

DATE/SITE: 1963, 1964/AMR

ORBIT: Apogee 300,000 km, Perigee 300 km,
inclination 33°

EXPECTED
LIFETIME: 1 year

HEADQUARTERS
CONTACT: J. Freeman
Alternate: E. Ehrlich

EXPERIMENTER: J. A. Simpson, Univ. of Chicago
G. Gloeckler, Univ. of Chicago

PARAMETER: Cosmic rays

EXPERIMENT: Measure solar and galactic protons and
alpha particles, 5-200 Mev

TECHNIQUE: Range vs. energy loss

INSTRUMENT: Solid state detectors

DISCIPLINE: Particles & Fields

SATELLITES

PROJECT

DESIGNATION: IMP-A, B, & C (Contd.)

EXPERIMENTER: F. B. McDonald, GSFC
G. Ludwig, GSFC

PARAMETER: Cosmic rays

EXPERIMENT: Measure solar and galactic protons,
10-100 MevTECHNIQUE: de
E by dx counter telescopeINSTRUMENT: Crystal and scintillation detectors, GM
counters

DISCIPLINE: Particles & Fields

EXPERIMENTER: K. A. Anderson, Univ. of California, Berkeley

PARAMETER: Trapped particles

EXPERIMENT: Identify and measure energies and pitch
angle distributions of trapped particlesTECHNIQUE: Ionization detector plus particle
detector

INSTRUMENT: Ionization chamber; thin-wall Geiger tubes

DISCIPLINE: Particles & Fields

SATELLITES

PROJECT

DESIGNATION: IMP-A, B, & C (Contd.)

EXPERIMENTER: N. F. Ness, GSFC

PARAMETER: Magnetic field

EXPERIMENT: Measurement of the geomagnetic field,
interplanetary magnetic field and fluctuationsTECHNIQUE: Scalar and vector measurements of
magnetic field

INSTRUMENT: Rb vapor and fluxgate magnetometers

DISCIPLINE: Particles & Fields

EXPERIMENTER: H. Bridge, MIT
B. Rossi, MIT

PARAMETER: Plasma

EXPERIMENT: Measure flux and energy of interplanetary
plasma; protons and electrons 0 to 8 kevTECHNIQUE: Plasma energy measurement with retarding
electric fields

INSTRUMENT: Faraday cup plasma probe

DISCIPLINE: Particles & Fields

SATELLITES

PROJECT

DESIGNATION: IMP-A, B, & C (Contd.)

EXPERIMENTER: J. Wolfe, Ames Research Center

PARAMETER: Plasma

EXPERIMENT: Measure interplanetary plasma flux and
velocity protons 0.2 to 2 kev

TECHNIQUE: Energy separation with electric fields

INSTRUMENT: Curved plate electrostatic analyzer

DISCIPLINE: Particles & Fields

EXPERIMENTER: G. P. Serbu, GSFC
R. Bourdeau, GSFC

PARAMETER: Plasma

EXPERIMENT: Measure thermal ions and electrons 0 to
10 ev

TECHNIQUE: Planar trap collection of thermal particles

INSTRUMENT: Planar trap ion-electron detector

DISCIPLINE: Ionospheres & Radio Physics (prime)
Solar Physics
Particles & Fields

SATELLITES

PROJECT
DESIGNATION: Orbiting Solar Observatory (OSO-B)

VEHICLE: Thor-Delta

DATE/SITE: 1Q64/AMR

ORBIT: Circular, 550 ± 55 km altitude; inclination 30°

EXPECTED
LIFETIME: 6 months - 1 year

HEADQUARTERS
CONTACT: H. G. Smith
Alternate R. Halpern

EXPERIMENTER: Leo Goldberg
E. M. Reeves
W. H. Parkinson Harvard Univ.
W. Liller

PARAMETER: Synoptic measurements of solar ultraviolet radiation (500 to 1500A)

EXPERIMENT: Solar ultraviolet spectrophotometric measurements in the region 500 - 1500A

TECHNIQUE: Ultraviolet solar scanning

INSTRUMENT: UV solar scanning spectrometer and spectroheliograph

DISCIPLINE: Solar Physics

SATELLITES

PROJECT

DESIGNATION: OSO-B (Contd.)

EXPERIMENTER: K. Frost, GSFC

PARAMETER: Low energy gamma rays in the region
100 kev to 300 kevEXPERIMENT: Search for solar ray flux in the
region 100 kev to 300 kev and if found
monitor its behavior in time and attempt
a correlation with solar activity.TECHNIQUE: By means of the revolutions of the wheel
portion of the satellite look at the
solar disc once every two seconds. In
particular the Sun is observed for three
successive rotations then the data are
processed for three successive rotations.
Once every two minutes a measurement is
made looking 120° away from the Sun for
three successive revolutions followed by
data processing as before. This cycle
is repeated.INSTRUMENT: Anti-coincident shielded ray spectrom-
eter

DISCIPLINE: Solar Physics

SATELLITES

PROJECT

DESIGNATION: OSO-B (Contd.)

EXPERIMENTER: Christopher P. Leavitt, Univ. of New Mexico

PARAMETER: Study of high energy gamma rays (50 Mev
and greater)EXPERIMENT: Detect the incident proportion of the
high energy cosmic primary radiation and
determine the angular and energy dis-
tribution.TECHNIQUE: Measure the energy of each incident gamma
ray through the conversion of a large
fraction of its energy into fast electrons.
To insure directional response and im-
prove energy resolution it will be
necessary to convert the photons before
they enter the counter and require
coincidence between the pulse produced
by the conversion electrons in an
auxiliary counter and the Cerenkov
pulse. Use of anticoincidence counter
to rule out charged primaries.

INSTRUMENT: Lead glass Cerenkov counter

DISCIPLINE: Solar Physics (prime)
Astronomy

SATELLITES

PROJECT

DESIGNATION: OSO-B (Contd.)

EXPERIMENTER: T. Chubb, Naval Research Laboratory
R. Kreplin, Naval Research Laboratory

PARAMETER: Solar X-ray emission

EXPERIMENT: Pinhole scan of Sun in wave length
regions of 8-20 \AA , 44-60 \AA . Monitoring of
X-ray bursts in prominences in wave
lengths of 2-8 \AA , 8-20 \AA , and 44-60 \AA TECHNIQUE: Use of Geiger counters to measure X-rays
during solar events and to scan solar
surface

INSTRUMENT: Geiger counters

DISCIPLINE: Solar Physics

EXPERIMENTER: R. Tousey, Naval Research Laboratory
J.D.Purcell, Naval Research Laboratory

PARAMETER: Solar UV emission

EXPERIMENT: Synoptic ultraviolet scanning measure-
ments in the regions 304 \AA and 584 \AA and
in the Lyman alpha wave length of 1215 \AA .TECHNIQUE &
INSTRUMENT: Use scanning UV photometers

DISCIPLINE: Solar Physics

SATELLITES

PROJECT

DESIGNATION: OSO-B (Contd.)

EXPERIMENTER: R. Tousey, Naval Research Laboratory
 J.D.Purcell, Naval Research Laboratory

PARAMETER: Structure of corona

EXPERIMENT: White light coronagraph measurements to
 study the structure of the outer solar
 atmosphere and its relation to the
 interplanetary medium.TECHNIQUE &
INSTRUMENT: Use white light coronagraph

DISCIPLINE: Solar Physics

EXPERIMENTER: K. L. Hallam, GSFC
 W. A. White, GSFCPARAMETER: Stellar and nebular UV spectra from 900
 to 3800AEXPERIMENT: Examine sky for stellar and nebular
 sources emitting in the wavelength
 regions 900-2000 Å and 1800-3800 Å.
 The experiment is considered a precursor
 to a similar experiment to be flown on
 an OAO.TECHNIQUE: Employ an objective grating spectrograph
 which uses the rotation of the wheel of
 the satellite with an azimuth grating
 for spatial scanning. Pulse counting is
 employed.

INSTRUMENT: Stellar spectrophotometer

DISCIPLINE: Astronomy

SATELLITES

PROJECT

DESIGNATION: OSO-B (Contd.)

EXPERIMENTER: E. P. Ney, Univ. of Minnesota

PARAMETER: Intensity and degree of polarization of
 zodiacal light at 4750 Å and 8500 Å.

EXPERIMENT: Direct measurement of the distribution
 and spectral characteristics of zodiacal
 light.

TECHNIQUE: Scan celestial sphere using precession of
 spacecraft spin axis. Instruments look
 90° apart above interference from atmos-
 pheric polarization and airglow.

INSTRUMENT: Two sets of photomultipliers. Each set
 has one visible and one IR sensitive
 photomultiplier with polaroid filters.

DISCIPLINE: Astronomy (prime)
 Planetary Atmospheres

SATELLITES

PROJECT
DESIGNATION: Orbiting Solar Observatory (OSO-C)

VEHICLE: Delta

DATE/SITE: 4Q64/AMR

ORBIT: Circular 300 km

EXPECTED LIFETIME: 1 year

HEADQUARTERS
CONTACT: H. G. Smith
Alternate: R. Halpern

Pointing Section
EXPERIMENTER: H. E. Hinteregger, AFCRL

PARAMETER: Solar extreme UV photon fluxes (1300-60Å)

EXPERIMENT: Measure solar flux and its variations in this range to study the Sun and its effects on the Earth's atmosphere.

TECHNIQUE: Point monochromator accurately at the solar disc for relatively long periods of time

INSTRUMENT: Monochromator

DISCIPLINE: Solar Physics

SATELLITES

PROJECT

DESIGNATION: OSO-C (Pointing Section) (Contd.)

EXPERIMENTER: J. C. Lindsay, GSFC
 W. M. Neupert, GSFC
 W. E. Behring, GSFC
 W. A. White, GSFC

PARAMETER: Solar spectrum 1-400⁰Å

EXPERIMENT: Measure the electromagnetic radiation
 for the total Sun observing spectro-
 metrically in the regions 1-3.8, 3.6-
 8.4, 8.2-25, and 25-400⁰Å and by ion
 chambers in the regions 1-8 and 10-
 20⁰Å

TECHNIQUE: Measure solar electromagnetic radiation
 using both the Sun's rotation and
 correlation and ground-based observa-
 tions to locate the source of radiation
 on the solar disc.

INSTRUMENT: Spectrometers and X-ray ion-chambers

DISCIPLINE: Solar Physics

SATELLITES

PROJECT

DESIGNATION:

OSO-C (Pointing Section) (Contd.)

EXPERIMENTER: H. Friedman, Naval Research Laboratory
T. A. Chubb, Naval Research Laboratory

PARAMENTER: Solar X-rays

EXPERIMENT: Distinguish between emissions from a thermally excited coronal plasma and the Bremsstrahlung X-rays produced by fast electrons injected into a relatively low-temperature corona

TECHNIQUE: Instruments scan wavelengths from 1-8 \AA about once every 5 minutes

INSTRUMENT: Bragg crystal spectrometer with Geiger counter detector

DISCIPLINE: Solar Physics

SATELLITES

PROJECT

DESIGNATION: OSO-C Pointing Section) (Contd.)

EXPERIMENTER: T. A. Chubb (C), Naval Research Laboratory
R. Tousey (T), Naval Research LaboratoryPARAMETER: (C) Solar X-ray 2-8, 8-20, 44-60⁰_Å
(T) White light corona
(T) Solar UVEXPERIMENT: (C) Map X-ray sources on the Sun.
(package) Monitor solar X-ray bursts.
Search for X-ray from prominences
high above solar limb.
(T) Map intensity of white light corona
of artificially eclipsed Sun.
Scan the solar disk in 8-20 and 44-
60⁰_Å UV light.TECHNIQUE: (C) Use Geiger counters to measure X-rays
during solar events and to scan
solar surface.
(T) Use white light coronagraph.INSTRUMENT: (C) Geiger counters
(T) End window type photomultipliers;
white light coronagraph with dis-
persing grating and UV photomul-
tipliers

DISCIPLINE: Solar Physics

SATELLITES

PROJECT

DESIGNATION: OSO-C (Contd.)

Wheel Section

EXPERIMENTER: L. E. Peterson, Univ. of Calif., La Jolla

PARAMETER: X-ray bursts

EXPERIMENT: Study energy spectrum and time dependence of X-ray bursts from Sun in energy region 15 kev-600 kev, including X-rays from solar Bremsstrahlung.

TECHNIQUE: Monitor Sun a large fraction of the time and detect events with intensities as low as 0.1 photon/cm^2 at the Earth

INSTRUMENT: NaI scintillation counter with phoswich and pulse height analyzer

DISCIPLINE: Solar Physics

EXPERIMENTER: R. G. Teske, Univ. of Michigan

PARAMETER: X-ray flux in range $8-20\text{\AA}$ EXPERIMENT: Measure X-ray flux from $8-20\text{\AA}$ emanating from visible solar hemisphere

TECHNIQUE: Compare satellite observations with optical and radio aspect of solar disk

INSTRUMENT: Two gas-filled ionization chambers with suitable window material

DISCIPLINE: Solar Physics

SATELLITES

PROJECT

DESIGNATION: OSO-C (Wheel Section) (Contd.)

EXPERIMENTER: W. L. Kraushaar, MIT

PARAMETER: Extra-solar gamma-rays with energies
 above 100 Mev

EXPERIMENT: Search for -ray sources among such
 likely candidates as the Crab Nebula,
 Cygnus A, Virgo Cluster, Sun, etc.

TECHNIQUE: Using -ray detectors measure the
 integral along the line of sight of the
 product of cosmic ray flux and matter
 density

INSTRUMENT: -ray convertors, Cerenkov counters,
 plastic scintillation counters, and
 photomultipliers

DISCIPLINES: Astronomy (prime)
 Solar Physics

SATELLITES

PROJECT

DESIGNATION: OSO-C (Wheel Section) (Contd.)

EXPERIMENTER: C. B. Neel, Ames Res. Center
G. G. Robinson, Ames Res. Center

PARAMETER: Intensity of Earth-reflected solar
radiation in the wave lengths 1000Å
to 30 microns

EXPERIMENT: Measure spectral intensity of Earth-
reflected solar energy over wave length
region from 1000Å to 4 microns. In
addition it is proposed to extend the
measurements into the infrared up to
amount 30 microns to obtain data on the
direct radiation from the Earth.

TECHNIQUE: Photometric sensors would be mounted on
the periphery of the rotating wheel to
measure spectral distributions of
radiant energy. The location of the
detectors permits determination of the
angular distribution of reflection
radiation as horizon to horizon scan
occurs. Momentary looks at the sun
provide calibration.

INSTRUMENT: Photomultiplier tubes

DISCIPLINE: Planetary Atmospheres (prime)
Astronomy

SATELLITES

PROJECT

DESIGNATION: OSO-C (Wheel Section) (Contd.)

EXPERIMENTER: E. M. Hafner, Univ. of Rochester
M. F. Kaplon, Univ. of Rochester

PARAMETER: Solar and galactic cosmic rays

EXPERIMENT: To measure charge and energy spectra
of charged particles of energies 3.3
Mev/nucleon

TECHNIQUE: Detector unidirectionally sensitive to
relativistic particles ($\beta \geq 0.72$) which
would discriminate between protons
($Z = 1$), alpha particles ($Z = 2$), and
the L group of nuclei ($3 \leq Z \leq 5$), the
M group of nuclei ($6 \leq Z \leq 9$) and the
H group ($Z \geq 10$). The detector will
also be sensitive to all charged particles
received corresponding to $\beta \geq 0.35$
for protons and correspondingly high
for higher charged particles.

INSTRUMENT: Counter telescope with scintillators and
Cerenkov radiators

DISCIPLINE: Particles & Fields (prime)
Solar Physics

SATELLITES

PROJECT

DESIGNATION:

OSO-C (Wheel Section) (Contd.)

EXPERIMENTER: S. Bloom J. Waggoner) Univ. of Calif.
 C. Schrader R. Kaifer) Lawrence Radiation
 Laboratory

PARAMETER: Trapped particles

EXPERIMENT: To study the lower region of the radiation belts by discriminating between electron ionization events and proton ionization events

TECHNIQUE: Solid state detection of particles and discrimination by energy loss

INSTRUMENT: Proton-electron discriminator

DISCIPLINE: Particles & Fields

SATELLITES

PROJECT
DESIGNATION: Orbiting Solar Observatory (OSO-D)

VEHICLE: Thor-Delta

DATE/SITE: 1965/AMR

TRAJECTORY: 480 km; 30⁰ inclination

EXPECTED
LIFETIME: 6 months to 1 year

HEADQUARTERS
CONTACT: H. G. Smith
Alternate: R. Halpern
Pointing Section
EXPERIMENTER: H. Friedman, Naval Research Laboratory
T. A. Chubb, Naval Research Laboratory

PARAMETER: Solar flare X-rays

EXPERIMENT: This proposal is for an experiment to distinguish between emissions from a thermally-excited coronal plasma and the Bremsstrahlung X-rays produced by fast electrons injected into a relatively low temperature corona.

TECHNIQUE: X-ray crystal spectrometry

INSTRUMENT: The instrumentation will be a Bragg crystal spectrometer with a Geiger counter detector. These instruments will be arranged to scan wavelengths from 1 to 8 angstroms.

DISCIPLINE: Solar Physics

SATELLITES

PROJECT

DESIGNATION:

OSO-D (Pointing Section) (Contd.)

EXPERIMENTER: L. Goldberg, Harvard College Observatory
E. M. Reeves, Harvard College Observatory
W. H. Parkinson, Harvard College Observatory

PARAMETER: Solar UV spectrum ($300\text{\AA} - 1300\text{\AA}$)

EXPERIMENT: Scan the solar disc in the UV between 300\AA and 1300\AA and make a plot of the intensity of this region of the spectrum.

TECHNIQUE: Vacuum ultraviolet spectroscopy

INSTRUMENT: This experiment will incorporate a long wavelength spectrometer capable of scanning the spectrum of a selected portion of the solar disc between the wavelength limits 300 to 1300\AA . The angular acceptance cone of the optical system will be such that a square of approximately 1.8 minutes of arc from the central portion of the solar disc may be spectroscopically analyzed over the above wavelength region with a 3\AA resolution.

DISCIPLINE: Solar Physics

SATELLITES

PROJECT

DESIGNATION: OSO-D (Pointing Section) (Contd.)

EXPERIMENTER: R. Giacconi, American Science & Engineering, Inc.

PARAMETER: Solar X-rays

EXPERIMENT: The objectives of this experiment are as follows: a) obtain a map of the sun in X-rays with an angular resolution of better than 2 minutes of arc in a time of the order of minutes in a given X-ray spectral region, b) extend observation of X-ray emission of the solar corona out to distances of about 1 solar radius, c) perform a preliminary spectrum analysis of the radiation emitted from the various regions of the sun in 3 broad spectrum ranges: between 8 and 20Å, above 20Å, and possibly below 8Å, d) study the temporal variations of solar X-ray emission with a time resolution of the order of minutes and over a period of time of the order of many months. This experiment will share compartment space with the NRL Bragg crystal spectrometer.

TECHNIQUE: Soft X-ray photography and photometry

INSTRUMENT: The instrument consists of a parabolic mirror on which X-rays impinge at grazing incidence and are totally reflected. Paraxial rays are focused onto a small region where a detector is placed. The detector is of the open-end electron multiplier type.

DISCIPLINE: Solar Physics

SATELLITES

PROJECT

DESIGNATION: OSO-D (Contd)

Wheel Section

EXPERIMENTER: R. Giacconi, American Science & Engineering, Inc.

PARAMETER: Non-solar cosmic X-rays

EXPERIMENT: The scientific objectives of the proposed experiment are a) survey the directional intensity of non-solar cosmic X-rays, b) obtain a rough survey of their spectral composition between 10\AA and 0.1\AA , c) distinguish between the stellar and the synchrotron component, d) correlate regions of strong intensity with optical and radio objects of special interest, and e) study auroral X-rays.

TECHNIQUE: Scintillometer spectroscopy

INSTRUMENT: The detectors for the 1.0\AA to 0.1\AA consist of a thin crystal of CsI viewed by two photomultipliers. In the region between 1.0\AA and 10\AA by a detector of SrF_2 deposited on top of a plastic scintillator

DISCIPLINE: Solar Physics

SATELLITES

PROJECT

DESIGNATION: OSO-D (Wheel Section) (Contd.)

EXPERIMENTER: E. A. Stewardson
 R. L. F. BoydCONTRACTOR/
AGENCY:Leicester University & University College,
London

PARAMETER: Solar X-rays

EXPERIMENT: This experiment will study the soft
X-ray region of the solar spectrum over
a wider wavelength range than has hitherto
been attempted at one time.

TECHNIQUE: Gaseous discharge photon counters

INSTRUMENT: Proposed wavelength ranges are 1.2\AA to
 3.6\AA , 3 to 9\AA , 6 to 18\AA , 44 to 55\AA , and
44 to 70\AA . The first three ranges will
be covered by proportional counters,
each range being further subdivided into
8 parts by means of an 8 channel differ-
ential analyzer. The last 2 ranges will
be viewed by Geiger counters with suitable
gas tight windows.

DISCIPLINE: Solar Physics

SATELLITES

PROJECT

DESIGNATION: OSO-D (Wheel Section) (Contd.)

EXPERIMENTER: J. A. Waggoner
 S. D. Bloom
 C. D. Schrader
 R. Kaifer

CONTRACTOR/

AGENCY: University of California, Livermore

PARAMETER: Charged particles

EXPERIMENT: This experiment will detect and identify
 electrons with energy greater than 60 kev
 and protons with energy greater than
 2 Mev.

TECHNIQUE: Scintillometerspectroscopy

INSTRUMENT: The instrument consists of a crystal and
 a photomultiplier with a collimator. A
 multi-channel pulse-height analyzer is
 included.

DISCIPLINE: Particles & Fields (prime)
 Solar Physics

SATELLITES

PROJECT

DESIGNATION: OSO-D (Wheel Section) (Contd.)

EXPERIMENTER: R. L. F. Boyd

CONTRACTOR/
AGENCY:

University College, London

PARAMETER: HeII Line (304⁸Å)

EXPERIMENT: The experiment will provide accurate independent determination of the absolute value of the quiet sun component of the solar flux together with data on the short-term enhancement due to localized solar activity.

TECHNIQUE: Monochromator photometry

INSTRUMENT: A 30,000 line per inch grating at grazing incidence is used. Detection is by a photomultiplier. The angular field of view is 2 degrees.

DISCIPLINE: Solar Physics

SATELLITES

PROJECT

DESIGNATION: OSO-D (Wheel Section) (Contd.)

EXPERIMENTER: T. A. Chubb
R. W. Kreplin
H. Friedman

CONTRACTOR/

AGENCY: Naval Research Laboratory

PARAMETER: Solar X-rays

EXPERIMENT: The experiment will provide absolute indices of solar activity, established by routine measurements of solar X-rays in the region between 0.1Å and 16Å.

TECHNIQUE: Gaseous discharge photon detectors

INSTRUMENT: This experiment will consist of 4 ion chamber photometers sensitive respectively to the bands 8 to 16Å, 2 to 8Å, 0.5 to 3Å, and 0.1 to 1.6Å.

DISCIPLINE: Solar Physics (prime)
Ionospheres & Radio Physics

SATELLITES

PROJECT

DESIGNATION: OSO-D (Wheel Section) (Contd)

EXPERIMENTER: T. W. Mange
T. A. Chubb
H. Friedman

CONTRACTOR/
AGENCY: Naval Research Laboratory

PARAMETER: Lyman-alpha night skyglow

EXPERIMENT: Determine the ratio of sky glow to albedo and the variation of flux from horizon to horizon through the anti-solar point at all hours of local time. Precession of the orbit will survey the latitude dependence.

TECHNIQUE: Each rotation of the wheel provides a scan of the sky, indicating the ratio of sky glow to albedo and the flux variation from horizon to horizon through the anti-solar point. Each orbit provides a day-night comparison. The experiment is on for one complete orbit out of four - less frequent if data are redundant, more frequent for periods of high magnetic activity.

INSTRUMENT: Two separate signal channels, each consisting of a Lyman-Alpha sensitive ion-chamber detector and associated electronics. The detectors have an optical field of 10° half maximum width, tilted 15° above plane of wheel to avoid interception of the sun. The overall gain of the two channels differs by a factor of 1 to 8 for day and night observations.

DISCIPLINE: Planetary Atmospheres

SATELLITES

PROJECT

DESIGNATION: OSO-D (Wheel Section) (Contd.)

EXPERIMENTER: E. A. Stewardson
R. L. F. Boyd

CONTRACTOR/

AGENCY: University College, London and Leicester
University

PARAMETER: Solar X-rays

EXPERIMENT: This experiment will study solar X-ray
flux in the 8 to 18 \AA and 3 to 9 \AA ranges.

TECHNIQUE: Gaseous discharge photon counters

INSTRUMENT: Proportional counters are used for the
two ranges (8 to 18 \AA and 3 to 9 \AA). The
overlap is considered highly desirable.

DISCIPLINE: Solar Physics

SATELLITES

PROJECT
DESIGNATION: Orbiting Solar Observatory (OSO-E)

VEHICLE: Thor Delta

DATE/SITE: 1966/AMR

TRAJECTORY: 480 km; 30° inclination

EXPECTED
LIFETIME: 6 months to 1 year

HEADQUARTERS
CONTACT: H. G. Smith
Alternate: R. Halpern
Pointing Section
EXPERIMENTER: E. A. Stewardson
R. L. F. Boyd

CONTRACTOR/
AGENCY: University College, London and
Leicester University

PARAMETER: Solar X-rays

EXPERIMENT: This experiment will study solar X-ray
flux in the 8 to 18Å and 3 to 9Å ranges.

TECHNIQUE: Gaseous discharge photon counters

INSTRUMENT: Proportional counters are used for the
2 ranges (8 to 18Å and 3 to 9Å). The
overlap is considered highly desirable.

DISCIPLINE: Solar Physics

SATELLITES

PROJECT

DESIGNATION: OSO-E (Pointing Section) (Contd.)

EXPERIMENTER: J. C. Lindsay, GSFC
W. M. Neupert, GSFC
W. E. Behring, GSFC
W. A. White, GSFC

PARAMETER: Solar X-ray and ultraviolet spectrum

EXPERIMENT: This experiment will measure the electromagnetic radiation from the total sun in the wavelength from 1 to 400Å and is a continuation of the studies previously started on OSO-I.

TECHNIQUE: Vacuum ultraviolet spectroscopy

INSTRUMENT: Improved version of the instrument to be flown on OSO-C.

DISCIPLINE: Solar Physics

SATELLITES

PROJECT

DESIGNATION: OSO-E (Contd)

Wheel Section

EXPERIMENTER: J. Blamont

CONTRACTOR/

AGENCY: University of Paris

PARAMETER: Solar Lyman-alpha

EXPERIMENT: This experiment will monitor the self-reversal of solar Lyman-alpha line.

TECHNIQUE: Monochromatic photometry

INSTRUMENT: The instrument will be an atomic hydrogen absorption cell.

DISCIPLINE: Solar Physics

EXPERIMENTER: T. A. Chubb
R. W. Kreplin
H. Friedman

CONTRACTOR/

AGENCY: Naval Research Laboratory

PARAMETER: Solar X-rays

EXPERIMENT: This experiment will provide absolute indices of solar activity by routine X-ray measurements.

TECHNIQUE: Gaseous discharge photon detectors

INSTRUMENT: Four sets of standardized X-ray ion chamber photometers. This is a duplication of the experiment to be flown on OSO-D.

DISCIPLINE: Solar Physics (prime)
Ionospheres & Radio Physics

SATELLITES

PROJECT

DESIGNATION: OSO-E (Wheel Section) (Contd.)

EXPERIMENTER: K. Frost, GSFC
 H. Horstman, GSFC
 E. Rothe, GSFC

PARAMETER: Solar Gamma Rays

EXPERIMENT: This experiment is a continuation of
 studies of solar flux in the 5 kev to
 150 kev energy region.

TECHNIQUE: Energetic photon detection quantum
 detector

INSTRUMENT: Instrumentation will be a gamma ray
 scintillation detector. These data will
 supplement measurements to be made on
 OSO-B.

DISCIPLINE: Solar Physics

SATELLITES

PROJECT
DESIGNATION: Orbiting Astronomical Observatory (OAO-A)

VEHICLE: Atlas-Agena D

DATE/SITE: 1965/AMR

ORBIT: Circular; 800 km altitude; 32° inclination

EXPECTED
LIFETIME: 1 year

HEADQUARTERS
CONTACT: N. G. Roman
Alternate: A. H. Sures

EXPERIMENTER: A. D. Code, University of Wisconsin

PARAMETER: Broad band photometric studies of stellar energy distribution in selected portions of the sky in the region 1000 - 3000 Å.

EXPERIMENT: To determine stellar energy distribution of selected stars in the UV and to check that the energy distribution is not intrinsically variable. To measure emission line intensities of diffuse nebulae.

TECHNIQUE: Observations of several hundred stars of all spectral types

INSTRUMENT: (1) A multicolor filter photometer system using four 8 inch telescopes;
(2) a multicolor filter photometer for nebulae using a 16 inch telescope;
(3) two auxiliary scanning spectrometers

DISCIPLINE: Astronomy

SATELLITES

PROJECT

DESIGNATION: OAO-A (Contd.)

EXPERIMENTER: F. Whipple, Smithsonian Astrophysical
R. Davis Observatory

PARAMETER: Stellar UV radiation in ranges 3000 -
1700 \AA ; 2000 - 1050 \AA ; and 1500 - 1050 \AA .

EXPERIMENT: To survey the entire sky in the UV
spectrum in ranges 3000 to 1700 \AA ,
2000 to 1050 \AA , and 1500 to 1050 \AA .

TECHNIQUE: Record the brightnesses of about hot
stars, primarily spectral type A and
earlier. Map the form and brightness
characteristics of faint nebulae.

INSTRUMENT: The equipment will be four high-resolu-
tion telescopes (Schwarzschild cameras).
The detectors at the focal point of the
telescopes will be ultraviolet-sensitive
image forming devices (Uvicons)

DISCIPLINE: Astronomy

SATELLITES

PROJECT
DESIGNATION: Orbiting Astronomical Observatory (OAO-B)

VEHICLE: Atlas-Agena D

DATE/SITE: 1965/AMR

ORBIT: Circular, 800 km altitude; 32° inclination

EXPECTED
LIFETIME: 1 year

HEADQUARTERS
CONTACT: N. G. Roman
Alternate: A. H. Sures

EXPERIMENTER: J. Milligan, GSFC

PARAMETER: Obtain absolute spectrophotometric data on selected stars and nebulae in the range 1000 to 4000Å with 2Å resolution.

EXPERIMENT: Studies to determine composition and properties of early (type A & B) stars, as well as properties of variable stars and peculiar B stars.

TECHNIQUE: Observation of several thousand stars

INSTRUMENT: The optical system will employ a relatively fast 36" Cassegrain telescope with a large aperture spectrophotometer. Six photomultipliers will be used in a pulse-counting mode for data recovery.

DISCIPLINE: Astronomy

SATELLITES

PROJECT
DESIGNATION: Orbiting Astronomical Observatory (OAO-C)

VEHICLE: Atlas-Agena D

DATE/SITE: 1966/AMR

ORBIT: Circular, 800 km altitude, 32° inclination

EXPECTED
LIFETIME: 1 year

HEADQUARTERS
CONTACT: N. G. Roman
Alternate: A. H. Sures

EXPERIMENTER: L. Spitzer, Princeton University

PARAMETER: Quantitative spectrometer observations of the absorption spectrum of interstellar gas in the range 800 to 3000Å with 0.1Å resolution.

EXPERIMENT: This is a study of the composition and physical condition of the clouds of interstellar gas and dust. Since most interstellar atoms absorb only in the far UV, observations of these UV lines are required.

TECHNIQUE: The optical system will consist of a Cassegrain reflecting telescope feeding the entrance slit of a concave-grating spectrometer. The primary of the F/3 telescope will be 32 inches in diameter. The entrance slit and concave grating of the spectrograph are fixed, and photocells behind exit slits will scan the spectrum.

INSTRUMENT: Cassegrain reflecting telescope; concave-grating spectrometer; photocells

DISCIPLINE: Astronomy

SATELLITES

PROJECT

DESIGNATION:

OAO-C (Contd.)

EXPERIMENTER: R. L. F. Boyd

CONTRACTOR/

AGENCY:

University College, London and
Leicester University

PARAMETER:

X-ray emission of a wide assortment of
stars, nebulae, etc.

EXPERIMENT:

The scientific objectives are to study the X-ray emission of a wide assortment of stars, nebulae, etc. It may be possible to obtain a low resolution spectrum of the X-ray emission of the brighter objects in several minutes of continuous viewing. By comparing the spectra of a number of stars in the wavelength band 3-18Å with the radiation flux, if any, at 44-60Å, it should be possible, furthermore, to obtain information on the interstellar absorption of He and the heavier elements.

TECHNIQUE:

Reflector collects radiation and focuses it into a photon detector. The particular photon detector determines the wavelength range. A proportional gas counter will be used with each reflector providing telescopes sensitive in the bands 3-12Å, 8-18Å, and 44-60Å. Each gas counter will be surrounded (apart from a small aperture) by a scintillator of high sensitivity for primary cosmic rays and showers formed in the satellite material. Coincident pulses from a photomultiplier and the respective gas counter will mutually cancel. The three paraboloidal mirrors reflect the X-rays at grazing incidence and focus them upon the gas proportional- and solid state-detectors.

SATELLITES

PROJECT

DESIGNATION: OAO-C (Contd.)

INSTRUMENT: Three paraboloidal reflectors, three
photon detectors, and three gas counters

DISCIPLINE: Astronomy

SATELLITES

PROJECT
DESIGNATION: Orbiting Geophysical Observatory (OGO-A&B)

VEHICLE: Atlas-Agena B

DATE/SITE: 3Q63 and 2Q64/AMR

ORBIT: Perigee 280 km; Apogee 110,000 km;
inclination 31° ; period approximately
42 hours

EXPECTED
LIFETIME: 1 year with 70% probability

HEADQUARTERS
CONTACT: A. Schardt
Alternate: D. Ashworth

EXPERIMENTER: P. W. Mange, Naval Research Laboratory

PARAMETER: Intensity of scattered Lyman-alpha
radiation

EXPERIMENT: Determination of the distribution of
neutral hydrogen in the geocorona

TECHNIQUE: Ion chambers mounted to look in various
directions from stabilized vehicle measuring
the scattering of Lyman - radiation
from the sun due to neutral hydrogen

INSTRUMENT: Ion chambers

DISCIPLINE: Planetary Atmospheres

SATELLITES

PROJECT

DESIGNATION: OGO-A&B (Contd.)

EXPERIMENTER: W. M. Alexander, GSFC
C. W. McCracken, GSFCPARAMETER: Impact parameters such as vibration,
and ion formation from micrometeorite
collisionEXPERIMENT: Measurement of the mass and density
distribution of cosmic dust near the earth;
velocity distribution and radiants of
cosmic dust.TECHNIQUE: Composite cosmic dust detection system;
oriented on spacecraft; detecting ion
plasma and acoustin pulsesINSTRUMENT: Microphones, plasma detectors and velocity
discriminator

DISCIPLINE: Planetary Atmospheres

EXPERIMENTER: H. Taylor, GSFC
N. W. Spencer, GSFCPARAMETER: Density of positive ions in mass range
from 1 to 50 AMU and from 10 to 10^5 ions
per ccEXPERIMENT: Direct measurement of the distribution of
exospheric ionic compositionTECHNIQUE: On-board spectrometer to give direct
readings. By varying the retarding
potential of tube and by adjusting the
gain of amplifier, entire range is
covered.

INSTRUMENT: Ruggedized RF ion mass spectrometer

DISCIPLINE: Planetary Atmospheres (prime)
Ionospheres & Radio Physics

SATELLITES

PROJECT

DESIGNATION: OGO-A&B (Contd.)

EXPERIMENTER: F. B. McDonald, GSFC
G. Ludwig, GSFC

PARAMETER: Primary cosmic radiation

EXPERIMENT: Determine the charge and energy spectra
of the primary cosmic radiation to assist
in determining the interstellar material
and to study cosmic ray modulation
mechanisms.TECHNIQUE: Scintillation detection, energy measure-
ment by pulse height discrimination and
analysis

INSTRUMENT: Cosmic ray telescope

DISCIPLINE: Particles & Fields

EXPERIMENTER: T. L. Cline, GSFC
E. N. Hones, Jr., Inst. for Defense
Analysis

PARAMETER: Low-energy positrons and gamma rays

EXPERIMENT: To detect and measure positrons (0 to
3 Mev) in the trapped particle belts and
in interplanetary space and to monitor
solar proton bursts (30 kev to 1.2 Mev)TECHNIQUE: Detection of gamma ray pair from positron
annihilation

INSTRUMENT: Double gamma ray spectrometer

DISCIPLINE: Particles & Fields (prime)
Solar Physics

SATELLITES

PROJECT

DESIGNATION: OGO-A&B (Contd.)

EXPERIMENTER: Leo R. Davis, GSFC

PARAMETER: Trapped particles

EXPERIMENT: To study spatial and temporal fluctuations of the trapped particle belts by observing trapped electrons with directional energy flux, 10 kev E 100 kev and the directional intensity of protons (120 kev E 4.5 Mev)

TECHNIQUE: Detection of charged particles by scintillation in phosphor layer. Energy measurement by range of particles in various absorbers

INSTRUMENT: Ion-electron scintillation detector

DISCIPLINE: Particles & Fields

EXPERIMENTER: E. J. Smith, JPL
Robert E. Holzer, UCLA

PARAMETER: Magnetic field

EXPERIMENT: Investigate magnetic field fluctuations in the range 0.01 to 1,000 cps and to investigate their relation to surface fluctuations

TECHNIQUE: Detection of magnetic fluctuations by signals induced in search coils

INSTRUMENT: Triaxial search coil magnetometer

DISCIPLINE: Particles & Fields

SATELLITES

PROJECT

DESIGNATION: OGO-A&B (Contd.)

EXPERIMENTER: John A. Simpson, Univ. of Chicago
C. Y. Fan, Univ. of Chicago
Peter Meyer, Univ. of Chicago

PARAMETER: Low energy galactic cosmic radiation flux

EXPERIMENT: Investigate low energy galactic cosmic radiation, study energetic particle fluxes of protons above 0.2 Mev and other nuclei at high energies, and examine possibility of measuring isotopic abundances using solid state detector technique

TECHNIQUE: Detection of charged particles by energy loss in solid state detectors. Energy measurement by shielding and pulse height discrimination

INSTRUMENT: Solid state detectors and telescopes

DISCIPLINE: Particles & Fields

EXPERIMENTER: James P. Heppner, GSFC

PARAMETER: Magnetic field

EXPERIMENT: To measure magnitude and direction of the magnetic field vector over range 1 to 50,000 gammas to accuracy 1 gamma in order to study propagation of magnetic disturbances within the magnetosphere and the interaction between the solar wind and the earth's magnetic field.

TECHNIQUE: Measurement of scalar field magnitude by Rb vapor instrument. Measurement of direction with fluxgate sensors.

INSTRUMENT: Fluxgate and rubidium-vapor magnetometers

DISCIPLINE: Particles & Fields

SATELLITES

PROJECT

DESIGNATION: OGO-A&B (Contd.)

EXPERIMENTER: John R. Winckler, Univ. of Minnesota
Roger L. Arnoldy, Univ. of Minnesota

PARAMETER: Trapped radiation and cosmic radiation

EXPERIMENT: To study injection, trapping, and loss mechanisms in the trapped radiation belts.

TECHNIQUE: An electron spectrometer will measure electron energy up to 4 Mev, ionization and Geiger counters will monitor galactic cosmic radiation and continually monitor the earth's trapped radiation (electron energy from 20 kev to 20 Mev.)

INSTRUMENT: Magnetic electron spectrometer, ionization chamber, Geiger counters

DISCIPLINE: Particles & Fields

EXPERIMENTER: Kinsey A. Anderson, Univ. of California
Berkeley, California

PARAMETER: Solar cosmic rays

EXPERIMENT: Measure solar cosmic ray protons and solar X-rays to assist in studying emissions from solar fluxes and propagation to the earth (protons 10-90 Mev)

TECHNIQUE: Detection of protons and X-rays in scintillation detectors. Energy measurement by shielding and pulse height analysis.

INSTRUMENT: Scintillation type detector

DISCIPLINE: Particles & Fields (prime)
Solar Physics

SATELLITES

PROJECT

DESIGNATION: OGO-A&B (Contd.)

EXPERIMENTER: James A. Van Allen, State Univ. of Iowa
L. A. Frank, State Univ. of Iowa

PARAMETER: Trapped electrons

EXPERIMENT: Measure the omnidirectional intensities of electrons in the outer trapped particle region in order to understand the origin of the trapped radiation belts and fluctuations in the belts

TECHNIQUE: Detection of charged particles by Geiger counters. Energy determination by shielding and detector response.

INSTRUMENT: Geiger-Mueller tubes

DISCIPLINE: Particles & Fields

EXPERIMENTER: Herbert Bridge, MIT; A. Bonetti, MIT
B. Rossi, MIT; A. J. Lazarus, MIT
F. Scherb, MIT

PARAMETER: Interplanetary plasma

EXPERIMENT: To study the properties of plasma from the sun by measuring proton and electron flux, the energy spectrum, the direction of flux, and temporal and spatial variations of these quantities in the energy range from 10 ev to 10 kev

TECHNIQUE: Measurement of plasma flux and energy by collection in Faraday cup and modulation by electric fields

INSTRUMENT: Faraday cup plasma probe

DISCIPLINE: Particles & Fields (prime)
Ionospheres & Radio Physics

SATELLITES

PROJECT

DESIGNATION: OGO-A&B (Contd.)

EXPERIMENTER: J. Wolfe, Ames Research Center

PARAMETER: Interplanetary plasma

EXPERIMENT: To study plasma from the sun by measuring
proton concentrations ranging from 10^{-2}
to 10^{-4} particles per cm^3 as a function
of proton energy in the range 0.2 to
20 kev

TECHNIQUE: Measurement of plasma energy by analysis
with curved plate spectrometer

INSTRUMENT: Curved plate plasma probe

DISCIPLINE: Particles & Fields (prime)
Ionospheres & Radio Physics

SATELLITES

PROJECT

DESIGNATION: OGO-A&B (Contd.)

EXPERIMENTER: F. T. Haddock, Univ. of Michigan

PARAMETER: Measure cosmic noise at two fixed frequencies in the range between 2 and 4 Mc/s

EXPERIMENT: Map the brightness distribution of cosmic radio noise over the sky. At present ground observations are limited to about 10 Mc/s and higher so maps at 2 to 4 Mc/s are expected to show significant changes from available maps.

TECHNIQUE: The sweep-frequency electrically-timed receiver measures the radio noise incident upon the 30-foot antenna. A solid-state intense noise source intermittently calibrates the gain of the receiver over the receiver frequency band. A reactance bridge intermittently measures the capacitance of the antenna to check erection and indirectly measure the ambient electron density. All measurements and calibrations will be made at intervals around the satellite orbit.

INSTRUMENT: Two frequency receivers, a 30 to 60 foot antenna, and associated equipment.

DISCIPLINE: Astronomy (prime)
Ionospheres & Radio Physics
Solar Physics

SATELLITES

PROJECT

DESIGNATION: OGO-A&B (Contd.)

EXPERIMENTER: C. L. Wolff, GSFC
K. Hallam, GSFC
S. P. Wyatt, Univ. of Illinois

PARAMETER: Low-resolution isophotes of the anti-solar and Moulton point directions measuring infrared brightness, and degree of polarization.

EXPERIMENT: Investigation of Gegenschein

TECHNIQUE: Photomultiplier scan in the visible and infrared using Polariod filter and depending upon spacecraft stabilization

INSTRUMENT: Photomultiplier

DISCIPLINE: Astronomy (prime)
Planetary Atmospheres

EXPERIMENTER: R. C. Sagalyn, Air Force Cambridge Research Laboratory
M. Smiddy,

PARAMETER: Densities of positively and negatively charged particles, energy distributions of these particles to 1 kev, and potential of vehicle with respect to the undisturbed plasma.

EXPERIMENT: Measurement of the above quantities as functions of position and time.

TECHNIQUE: Two sensors, one for measurement of positively charged particles and one for negatively charged particles, each operated in at least three modes.

INSTRUMENT: Spherical three-electrode probe mounted on a boom.

DISCIPLINE: Ionospheres & Radio Physics (prime)
Particles & Fields
Planetary Atmospheres

SATELLITES

PROJECT

DESIGNATION: OGO-A&B (Contd.)

EXPERIMENTER: E. C. Whipple, Jr., GSFC

PARAMETER: Densities and temperatures of charged particles of both polarities, information on ion masses, fluxes and directions of energetic particle beams, polarity and magnitude of vehicle potential.

EXPERIMENT: Measurement of the above quantities as functions of position and time.

TECHNIQUE: Separation of particles according to their polarity and energy.

INSTRUMENT: Planar ion and electron trap

DISCIPLINE: Ionospheres & Radio Physics (prime)
 Particles & Fields
 Planetary Atmospheres

EXPERIMENTER: R. A. Helliwell, Stanford Univ.
 L. H. Rorden, Stanford Research Inst.

PARAMETER: Noise and signal amplitudes as a function of time, location, and frequency in the range 0.2 - 100 Kc/s

EXPERIMENT: Mapping of VLF noise and field strengths of signals

TECHNIQUE: Continuous synoptic noise survey, continuous monitoring of sudden commencement VLF noise bursts, recording samples of broadband VLF noise, and propagation characteristics of VLF and LF signals originating on the ground.

INSTRUMENT: Antenna and three frequency-stepping receivers covering the range of 200 cps to 100 kc.

DISCIPLINE: Ionospheres & Radio Physics

SATELLITES

PROJECT

DESIGNATION: OGO-A&B (Contd.)

EXPERIMENTER: H. J. A. Chivers, Central Radio Propagation
R. S. Lawrence, Laboratory, Natl. Bureau
of Standards

PARAMETER: Electron content, scintillations

EXPERIMENT: Radio beacon experiment to permit the
above parameters to be investigated as
functions of position and time.

TECHNIQUE: Faraday rotation, differential Doppler

INSTRUMENT: 40 Mc/s and 360 Mc/s transmitters with
switched 200 Kc/s and 20 Kc/s modulation

DISCIPLINE: Ionospheres & Radio Physics

SATELLITES

PROJECT
DESIGNATION: Orbiting Geophysical Observatory (OGO-C&D)

VEHICLE: Thor-Agena D (thrust augmented)

DATE/SITE: 1965/PMR

ORBIT: Perigee 260 km; Apogee 920 km; Inclination
82° to 90°, approximately 90 minutes

EXPECTED
LIFETIME: 1 year with 70% probability

HEADQUARTERS
CONTACT: R. F. Fellows
Alternate: C. D. Ashworth

EXPERIMENTER: W. R. Webber, Univ. of Minnesota

PARAMETER: Cosmic rays

EXPERIMENT: Measure rigidity and charge spectrum
of galactic and solar cosmic rays in
order to study origin and modulation
mechanisms of cosmic radiation

TECHNIQUE: Charged particle detection and energy
measurement by energy loss in Cerenkov-
scintillation telescope

INSTRUMENT: Scintillation-Cerenkov detector

DISCIPLINE: Particles & Fields (prime)
Solar Physics

SATELLITES

PROJECT

DESIGNATION: OGO-C&D (Contd.)

EXPERIMENTER: J. A. Van Allen State University of Iowa
L. A. Frank Iowa City, Iowa

PARAMETER: Trapped electrons

EXPERIMENT: Measure trapped and dumped electrons in order to study the origin and fluctuation mechanisms for the trapped particle belts

TECHNIQUE: Vertical and horizontal detectors in order to distinguish between trapped electrons and electrons in the loss cone

INSTRUMENT: Thin-window Geiger tubes

DISCIPLINE: Particles & Fields
Planetary Atmospheres

EXPERIMENTER: H. R. Anderson, Jet Propulsion Laboratory
H. V. Neher, California Institute of Technology

PARAMETER: Cosmic radiation

EXPERIMENT: Monitor cosmic radiation and trapped radiation with an instrument of well known response and with a long history of use in balloon measurements at high latitudes

TECHNIQUE: Charged particle detection by ionization chamber

INSTRUMENT: Integrating ionization detector

DISCIPLINE: Particles & Fields

SATELLITES

PROJECT

DESIGNATION: OGO-C&D (Contd.)

EXPERIMENTER: J. A. Simpson
E. C. Stone University of Chicago
C. Y. Fan

PARAMETER: Trapped radiation and low energy cosmic rays

EXPERIMENT: To study low energy protons and nucleons by measuring energetic particle flux from 0.3 Mev/nucleon to 30 Mev/nucleon

TECHNIQUE: Charged particle detection with scintillation telescope and electronic energy analysis

INSTRUMENT: Scintillation telescope

DISCIPLINE: Particles & Fields

EXPERIMENTER: L. R. Davis, GSFC: R. A. Hoffman, GSFC
A. Konradi, GSFC: J. M. Williamson, GSFC

PARAMETER: Trapped radiation

EXPERIMENT: To study fluctuations in the trapped radiation by measuring low energy trapped particles, 10-100 kev electrons and 100 kev-4.5 Mev protons

TECHNIQUE: Absorber wheel, energy discrimination, phosphor-photomultiplier scintillation detection

INSTRUMENT: Ion-electron detector

DISCIPLINE: Particles & Fields
Planetary Atmospheres

SATELLITES

PROJECT

DESIGNATION: OGO-C&D (Contd.)

EXPERIMENTER: H. R. Boroson, GSFC
J. Cain, GSFC
J. P. Heppner, GSFC

PARAMETER: Magnetic field

EXPERIMENT: Scalar magnetic field measurements for
Wold Magnetic SurveyTECHNIQUE: Scalar field measurement of high absolute
accuracy. Signal counting and storage
on board spacecraft

INSTRUMENT: Rb vapor magnetometer

DISCIPLINE: Particles & Fields

EXPERIMENTER: R. E. Holzer, UCLA
E. J. Smith, JPL

PARAMETER: Magnetic field fluctuations

EXPERIMENT: To measure magnetic field fluctuations
in low audio and sub audio range of
frequencies and to correlate these
measurements with surface fluctuationsTECHNIQUE: Detection of fluctuations in search
coils

INSTRUMENT: Triaxial search coil magnetometer

DISCIPLINE: Particles & Fields

SATELLITES

PROJECT

DESIGNATION: OGO-C&D (Contd.)

EXPERIMENTER: H. Taylor, GSFC
H. C. Brinton, GSFCPARAMETER: Measurement of atmospheric positive ion
composition and density in range 1-45 AMU.
Total ion current also measured.EXPERIMENT: Direct measurement of ion composition
and density as function of altitude,
geographic location, time of day, season,
and geophysical phenomenaTECHNIQUE: Appropriate voltage programming of grids
of RF ion mass spectrometer

INSTRUMENT: Ruggedized RF ion mass spectrometer

DISCIPLINE: Planetary Atmospheres (prime)
Ionospheres & Radio Physics

EXPERIMENTER: L. M. Jones, Univ. of Michigan
E. J. Schaefer, Univ. of MichiganPARAMETER: Neutral species and positive ions in
range 0 to 40 AMUEXPERIMENT: To obtain neutral and ionic composition
of atmosphere as a function of altitude,
geographic location, time of day, season,
and geophysical phenomenaTECHNIQUE: Using one sensor, program to measure
neutral, then to look at ions. Utilize
two mass ranges 0 - 6 AMU and 0 - 40 AMU.

INSTRUMENT: Paul Massenfilter spectrometer tube

DISCIPLINE: Planetary Atmospheres (prime)
Ionospheres & Radio Physics

SATELLITES

PROJECT

DESIGNATION: OGO-C&D (Contd.)

EXPERIMENTER: P. W. Mange, U.S. Naval Res. Lab.
T. A. Chubb, U.S. Naval Res. Lab.
H. Friedman, U.S. Naval Res. Lab.

PARAMETER: To measure Lyman-alpha and far UV
airglow measurements between 1230 and
1350Å

EXPERIMENT: To accurately record the spatial and
time variations of Lyman- night sky
glow, and to record intensities in 1230
to 1350Å emissions

TECHNIQUE: Direct measurement of UV airglow emission,
and of the Lyman-α

INSTRUMENT: Ion chambers having appropriate response

DISCIPLINE: Planetary Atmospheres

EXPERIMENTER: J. Blamont, Univ. of Paris
E. Reed, GSFC

PARAMETER: Airglow emission at 6300Å, 6200Å, 5577Å,
2600Å, 5890Å, and 3914Å.

EXPERIMENT: To measure the intensity of the airglow
emissions

TECHNIQUE: Direct measurement of airglow emission
using onboard sensors

INSTRUMENT: Appropriate photomultiplier and wide and
narrow pass band filter combinations

DISCIPLINE: Planetary Atmospheres

SATELLITES

PROJECT

DESIGNATION: OGO-C&D (Contd.)

EXPERIMENTER: W. M. Alexander, GSFC
 C. W. McCracken, GSFC
 O. E. Berg, GSFC
 L. Secretan, GSFC

PARAMETER: To measure amount of dust particles in
 10^{-13} to 10^{-9} gm range

EXPERIMENT: To measure flux, momentum, and mass of
 dust particles in 10^{-13} to 10^{-9} gm range
 in the zodiacal light

TECHNIQUE: To directly measure from outside the
 atmosphere of the Earth the distribution
 and selected physical parameters of dust
 particles in the zodiacal light.

INSTRUMENT: Combined electrostatic piezoelectric
 microphone detector

DISCIPLINE: Planetary Atmospheres

EXPERIMENTER: G. P. Newton, GSFC

PARAMETER: Variations in gage pressure in range from
 about 10^{-5} to 10^{-10} mm Hg

EXPERIMENT: To measure directly atmospheric density
 as a function of altitude, latitude, time
 of day, season, and geophysical phenomena

TECHNIQUE: Direct measurement of RAM pressure using
 sensor coupled to the atmosphere by an
 orifice

INSTRUMENT: Bayard-Alpert type ionization gauge

DISCIPLINE: Planetary Atmospheres (prime)
 Ionospheres & Radio Physics

SATELLITES

PROJECT

DESIGNATION: OGO-C&D (Contd.)

EXPERIMENTER: C. A. Barth, JPL
L. Wallace, Yerkes Observatory

PARAMETER: Intensity of upper atmosphere's UV
spectra 1100⁰Å to 3400⁰Å

EXPERIMENT: To measure with 10 Angstrom resolution
the Earth's ultraviolet spectra caused
by the aurora, day glow, twilight glow,
and night glow

TECHNIQUE: High resolution scan in the UV

INSTRUMENT: Scanning UV spectrophotometer

DISCIPLINE: Planetary Atmospheres

EXPERIMENTER: R. A. Helliwell, Stanford University

PARAMETER: Amplitudes, phases, and spectral composition
of VLF signals in the range 0.2 - 100 kc/s

EXPERIMENT: A VLF noise and propagation experiment
to map noise and investigate propagation
conditions as functions of place and time

TECHNIQUE: Compare amplitudes from transmitters
at different positions to obtain informa-
tion on ionospheric transmission co-
efficients. Phase and spectrum measure-
ments to provide information on whistler
ray paths.

INSTRUMENT: Loop antenna and VLF receiver, and two
transmitters at different positions in
orbit and on the ground.

DISCIPLINE: Ionospheres & Radio Physics

SATELLITES

PROJECT

DESIGNATION: OGO-C&D (Contd.)

EXPERIMENTER: M. G. Morgan, Dartmouth College
T. Laaspere, Dartmouth College

PARAMETER: Obtain the diurnal and latitude variations of the VLF spectra (high resolution) both in orbit and on the ground.

EXPERIMENT: Whistlers and VLF emissions. Investigation of whistler propagation and noise generation by simultaneous observations from the satellite and from the ground.

TECHNIQUE: Obtain high resolution samples of whistler spectra in conjunction with similar information from an existing chain of ground stations.

INSTRUMENT: Loop antenna and wide-band receiver to cover the approximate range of 500-10,000 cps.

DISCIPLINE: Ionospheres & Radio Physics

SATELLITES

PROJECT

DESIGNATION: OGO-C&D (Contd.)

EXPERIMENTER: R. E. Bourdeau, GSFC

PARAMETER: Electron temperature (800 to 3000 K);
ion or neutral gas temperature (800 to
3000 K) charged particle density (10^3 to
 5×10^6)

EXPERIMENT: To measure the parameters listed above as
a function of altitude, geographic
location, time of day, season, and geo-
physical phenomena

TECHNIQUE: Retarding potential analyzer for each
parameter.

INSTRUMENT: Two planar ion traps.

DISCIPLINE: Ionospheres & Radio Physics (prime)
Planetary Atmospheres

SATELLITES

PROJECT

DESIGNATION: OGO-C&D (Contd.)

EXPERIMENTER: F. T. Haddock, Univ. of Michigan

PARAMETER: Measure cosmic noise at two fixed frequencies in the range between 2 and 4 Mc/s

EXPERIMENT: Map the brightness distribution of cosmic radio noise over the sky. At present ground observations are limited to about 10 Mc/s and higher so maps at 2 to 4 Mc/s are expected to show significant changes from available maps.

TECHNIQUE: The sweep-frequency electrically-timed receiver measures the radio noise incident upon the 30-foot antenna. A solid-state intense noise source intermittently calibrates the gain of the receiver over the receiver frequency band. A reactance bridge intermittently measures the capacitance of the antenna to check erection and indirectly measure the ambient electron density. All measurements and calibrations will be made at intervals around the satellite orbit.

INSTRUMENT: Two frequency receivers, a 30 to 60 foot antenna, and associated equipment.

DISCIPLINE: Astronomy (prime)
Ionospheres & Radio Physics
Solar Physics

SATELLITES

PROJECT

DESIGNATION: OGO-C&D (Contd.)

EXPERIMENTER: R. W. Kreplin, Naval Research Laboratory
T. A. Chubb, Naval Research Laboratory
H. Friedman, Naval Research Laboratory

PARAMETER: Solar X-rays

EXPERIMENT: Time variation in solar X-ray emission
in the bands 0.5 to 3 \AA , 2-8 \AA , 8-16 \AA , and
44-60 \AA using an ionization chamber

TECHNIQUE: Measure the solar X-ray emission flux
for the entire sunlit portion of the
spacecraft orbit for correlation with
changes in the earth's atmosphere,
particularly the ionosphere.

INSTRUMENT: Ionization chambers covering the above
four ranges oriented toward the sun on
the solar oriented external package (SOEP).

DISCIPLINE: Planetary Atmospheres (prime)
Ionospheres & Radio Physics (prime)
Solar Physics

SATELLITES

PROJECT

DESIGNATION: OGO-C&D (Contd.)

EXPERIMENTER: H. E. Hinteregger, AFCRL

PARAMETER: Spectral distribution of solar energy
in the 170 to 1700Å regionEXPERIMENT: Monitor the variations of flux of the
above energy ranges for correlation with
changes in the earth's atmosphere.
Experiment is continuous for sunlit
portion of the orbit with both stored
and real-time data readout.TECHNIQUE: Solar EUV fluxes of above wavelengths
are monitored in a five-minute period in
six different ranges (170 - 422Å, 329 -
703Å, 395 - 843Å, 474 - 1012Å, 592 -
1264Å, and 790 - 1700Å). This is by the
use of six gratings and six photocathodes
oriented toward the sun on the solar oriented
external package (SOEP).DISCIPLINE: Planetary Atmospheres (prime)
Ionospheres & Radio Physics (prime)
Solar Physics

SATELLITES

PROJECT
DESIGNATION: International Satellite (UK-C&D)

VEHICLE: Scout

DATE/SITE: 1Q64/Wallops Island, Va.

ORBIT: Perigee 278 km; Apogee 1500 km; inclination angle 51°

HEADQUARTERS
CONTACT: R. F. Fellows
Alternate: R. E. Halpern

EXPERIMENTER: R. Frith, Air Ministry, London
K. H. Stewart, Air Ministry, London

PARAMETER: Intensity of solar ultraviolet absorption by ozone

EXPERIMENT: Measure the distribution of atmospheric ozone at twilight

TECHNIQUE: Absorption of solar radiation by ozone at twilight used to measure the total ozone content as a function of altitude and latitude

INSTRUMENT: Photo-cells and scanning spectrometer set for the ozone absorption bands

DISCIPLINE: Planetary Atmospheres

SATELLITES

PROJECT

DESIGNATION: UK-C&D (Contd.)

EXPERIMENTER: R. C. Jennison, Univ. of Manchester,
EnglandPARAMETER: Rate of hole formation in thin metallic
filmEXPERIMENT: Measure the impact rate, distribution,
and effects of micrometeoritesTECHNIQUE: Thin foil element penetrated by micro-
meteorites transmits sunlight. Frame
of foil is movable.

INSTRUMENT: Optical detection

DISCIPLINE: Planetary Atmospheres

EXPERIMENTER: F. G. Smith, Cambridge Univ., England

PARAMETER: Galactic radio noise in frequency range
0.75 Mc to 3.0 McEXPERIMENT: Mapping of galactic radio noise in above
frequency range, and investigation of
ionospheric effects at these frequencies

TECHNIQUE: Reception of signals on satellite

INSTRUMENT: Dipole antenna and receiver

DISCIPLINE: Ionospheres & Radio Physics (prime)
Astronomy

SATELLITES

PROJECT
DESIGNATION: San Marco (SM-A&B)

VEHICLE: Scout

DATE/SITE: 1964

ORBIT: Circular, equatorial, altitude between
150 - 300 km

EXPECTED
LIFETIME: Several weeks to several months

HEADQUARTERS
CONTACT: R. F. Fellows
Alternate: R. D. Ginter

EXPERIMENTER: Italian Space Commission

PARAMETER: Atmospheric density, temperature, and
ion content

EXPERIMENT: Determine the atmospheric density in the
equatorial region and the variations from
solar heating and other geophysical
phenomena

TECHNIQUE: Drag data and direct measurement

INSTRUMENT: Drag data by means of concentric spheres
connected by strain gages, ion probe

DISCIPLINE: Planetary Atmospheres (prime)
Ionospheres & Radio Physics (prime)

SATELLITES

PROJECT

DESIGNATION: San Marco (SM-A&B) (Contd.)

EXPERIMENTER: Italian Space Commission

PARAMETER: Electron content and ducted propagation

EXPERIMENT: Iono Beacon

TECHNIQUE: 20 Mc/s beacon frequency

INSTRUMENT: 20 Mc/s transmitter and ground-based
receiver

DISCIPLINE: Ionospheres & Radio Physics

SATELLITES

PROJECT
DESIGNATION: Relay B & C, Communication
Satellite

VEHICLE: Delta

DATE/SITE: 1Q64/AMR

ORBIT: Apogee 7400 km, Perigee 1300 km,
Inclination 47°

EXPECTED
LIFETIME: 1 year

HEADQUARTERS
CONTACT: L. Jaffe

EXPERIMENTER: W. Brown, Bell Telephone Laboratories

PARAMETER: Flux and energy spectrum of protons

EXPERIMENT: Determine proton energy spectrum ($2.5 \leq E$
 ≤ 25 Mev)

TECHNIQUE: Measurement of energy by energy loss in
detector and pulse height discrimination

INSTRUMENT: Solid state detectors

DISCIPLINE: Particles & Fields

SATELLITES

PROJECT

DESIGNATION: Relay B & C (Contd.)

EXPERIMENTER: W. Brown, Bell Telephone Laboratories

PARAMETER: Flux and energy spectrum of electrons

EXPERIMENT: Determine electron energy spectrum
($2.5 \leq E \leq 25$ Mev)

TECHNIQUE: Measurement of energy by energy loss in
solid state detector and by pulse height
discrimination

INSTRUMENT: Solid state detectors

DISCIPLINE: Particles & Fields

EXPERIMENTER: Carl McIlwain, State Univ. of Iowa-
flight hardware; Univ. of California-
data reduction

PARAMETER: Ominidirectional electron flux

EXPERIMENT: Measurement of omnidirectional flux
of electrons ($E \geq 5$ Mev)

TECHNIQUE: Measurement of energy by electronic
discrimination of light pulses in plastic
scintillator

INSTRUMENT: Shielded scintillation counter

DISCIPLINE: Particles & Fields

SATELLITES

PROJECT

DESIGNATION: Relay B & C (Contd.)

EXPERIMENTER: Carl McIlwain, State Univ. of Iowa-
flight hardware; Univ. of California-
data reduction

PARAMETER: Flux and energy spectrum of electrons

EXPERIMENT: Determine directional intensity and
energy distribution of electrons
($0.4 \leq E \leq 1.2$ Mev)

TECHNIQUE: Measurement of energy by electronic
discrimination of light pulses in plastic
scintillator

INSTRUMENT: Scintillation counter

DISCIPLINE: Particles & Fields

EXPERIMENTER: Carl McIlwain, State Univ. of Iowa-
flight hardware; Univ. of California-
data reduction

PARAMETER: Trapped proton flux and energy spectrum

EXPERIMENT: Determine directional intensity and energy
distribution of protons ($1 \leq E \leq 8.2$ Mev)

TECHNIQUE: Measurement of energy by electronic
discrimination of energy loss pulses
in solid state detector

INSTRUMENT: Silicon PN junction detector

DISCIPLINE: Particles & Fields

SATELLITES

PROJECT

DESIGNATION: Relay B & C (Contd.)

EXPERIMENTER: Carl McIlwain, State Univ. of Iowa-
flight hardware; Univ. of California-
data reduction

PARAMETER: Proton flux and energy spectrum

EXPERIMENT: Determine directional intensity and
energy distribution of protons ($18 \leq E$
< 60 Mev)

TECHNIQUE: Detection of higher energy protons
through coincidence counting and shielding
with two solid state detectors

INSTRUMENT: Silicon PN junction telescope

DISCIPLINE: Particles & Fields

SPACE PROBES

PROJECT
DESIGNATION: Ranger Block III
Rangers A, B, C, and D

VEHICLE: Atlas-Agena B

DATE/SITE: 1Q64; 2Q64; 3Q64/AMR

TRAJECTORY: Lunar impact

EXPECTED
LIFETIME: 66 hour trajectory to impact

HEADQUARTERS
CONTACT: N. W. Cunningham
Alternate: M. R. Gill

EXPERIMENTER: G. Kuiper, University of Arizona
H. C. Urey, University of Calif. at San Diego
E. Shoemaker, U.S. Geological Survey,
Flagstaff, Arizona
R. Heacock, Jet Propulsion Laboratory
E. Whitaker, University of Arizona

PARAMETER: Television picture of lunar surface

EXPERIMENT: To determine lunar topography from a series of TV pictures. Resolution of pictures will range from approximately 3300 feet for the first down to three feet for the last picture.

TECHNIQUE: Beginning at a lunar altitude of 5000 miles a series of TV pictures will be taken down to an altitude of about 1/3 mile. The resulting pictures will be examined and interpreted.

INSTRUMENT: An RCA TV system consisting of three one-inch and three three-inch vidicon cameras

DISCIPLINE: Planetology

SPACE PROBES

PROJECT
DESIGNATION: Surveyor E-H

VEHICLE: Atlas-Centaur

DATE/SITE: 1966, AMR

TRAJECTORY: Lunar Landing

EXPECTED
LIFETIME: Minimum of two weeks on lunar surface

HEADQUARTERS
CONTACT: Benjamin Milwitzky
Alternate: F. A. Zihlman

EXPERIMENTERS: E. M. Shoemaker, U.S. Geological Survey
G. P. Kuiper, Univ. of Arizona
E. Whitaker, Univ. of Arizona

PARAMETER: Topography and texture of lunar surface

EXPERIMENT: Obtain series of overlapping pictures of landing site and surrounding area during final descent phase. Obtain panoramic pictures from spacecraft after landing.

TECHNIQUE: The two horizontal cameras will be able to give 360° coverage around the spacecraft, and view from 15° above to 45° below the horizon. The horizontal cameras will have lenses with focal lengths variable from 25 to 100 mm. A series of pictures will be taken during the first descent phase.

INSTRUMENT: Two horizontal and one downward-looking television cameras

DISCIPLINE: Planetology

SPACE PROBES

PROJECT

DESIGNATION: Surveyor E-H (Contd.)

EXPERIMENTERS: R. F. Scott, Calif. Institute of Technology
R. M. Haythornwaite, Univ. of Michigan
R. A. Liston, U.S. Army Ordnance Land
Locomotion Laboratory

PARAMETER: Hardness, grain size and mechanical
characteristics of the lunar surface

EXPERIMENT: Surface sampler

TECHNIQUE: Use will be made of the modified surface
sampler originally designed to collect
samples for analysis. As the sampler is
manipulated measurements of surface
physical characteristics will be obtained
by strain gages and accelerometers.
The effects of the surface sampler in
manipulating the lunar surface material
will be visually monitored by means of
the television system.

INSTRUMENT: Surface sampler and TV

DISCIPLINE: Planetology

EXPERIMENTER: S. A. Batterson, Langley Research Center

PARAMETER: Hardness and bearing strength of lunar
surface

EXPERIMENT: Touchdown dynamics

TECHNIQUE: Strain gages and accelerometers will be
used to determine the forces acting on the
spacecraft landing gear and the penetration
of the landing gear pads into the lunar
surface.

INSTRUMENT: Strain gages, accelerometers and rate gyros.

DISCIPLINE: Planetology

SPACE PROBES

PROJECT

DESIGNATION: Surveyor E-H (Contd)

EXPERIMENTERS: A. Turkevich, Univ. of Chicago
J. Patterson, Argonne National Laboratory
E. Franzgrote, Jet Propulsion Laboratory

PARAMETER: Elemental distribution of lunar surface material from Li to Fe, Ni, Co.

EXPERIMENT: Elemental analysis of lunar surface material.

TECHNIQUE: Rutherford scattering of alpha particles from the lunar surface.

INSTRUMENT: Gold-silicon surface barrier diodes will be used to detect the Rutherford scattering of 6.1 Mev alpha-particles from a strong curium source. Both alpha particles and protons will be detected and measured.

DISCIPLINE: Planetology

EXPERIMENTERS: G. H. Sutton, Columbia Univ.
M. Ewing, Columbia Univ.
F. Press, Calif. Institute of Technology

PARAMETER: Lunar seismic activity and meteoritic impacts

EXPERIMENT: Determine seismic activity of the moon

TECHNIQUE: Passive seismometry

INSTRUMENT: Single axis seismometer

DISCIPLINE: Planetology

SPACE PROBES

PROJECT

DESIGNATION: Surveyor E-H (Contd.)

EXPERIMENTERS: W. M. Alexander, GSFC
O. E. Berg, GSFC
L. Secretan, GSFC
C. W. McCracken, GSFC

PARAMETER: Characteristics of secondary ejecta particles near the lunar surface.

EXPERIMENT: Measure the flux, momentum, and energy of secondary particles generated by meteoritic impacts.

TECHNIQUE: Measurement of particle momentum and energy from which particle mass and velocity can be derived.

INSTRUMENT: Micrometeorite detector

DISCIPLINE: Planetology

SPACE PROBES

PROJECT
DESIGNATION: Mariner C and D

VEHICLE: Atlas Agena

DATE/SITE: 1964/AMR

TRAJECTORY: Mars encounter

EXPECTED
LIFETIME: 8 months

HEADQUARTERS
CONTACT: J. Weldon
Alternate: G. Reiff

EXPERIMENTERS: Charles A. Barth, Jet Propulsion Laboratory
J. C. Brandt, Kitt Peak National Observatory
J. B. Pearce, Jet Propulsion Laboratory
L. Wallace, Kitt Peak National Observatory

PARAMETER: Atomic oxygen, atomic hydrogen, nitrogen

EXPERIMENT: Determine the relative abundances of
atomic oxygen, atomic hydrogen, and
molecular nitrogen in the upper atmosphere
of Mars

TECHNIQUE: Measure Lyman at 1216 Å and atomic oxygen
at 1300 Å

INSTRUMENT: Three sensor UV photometer

DISCIPLINE: Planetary Atmospheres

SPACE PROBES

PROJECT

DESIGNATION: Mariner C and D (Contd)

EXPERIMENTERS: R. B. Leighton, Calif. Institute of Technology
B. C. Murray, Calif. Institute of Technology
R. P. Sharp, Calif. Institute of Technology

PARAMETER: Martian surface

EXPERIMENT: Obtain TV pictures of Mars

TECHNIQUE: Optical telescope with vidicon tube

INSTRUMENT: Optical telescope with vidicon tube

DISCIPLINE: Planetology (prime)
Planetary Atmospheres

EXPERIMENTERS: E. J. Smith, Jet Propulsion Laboratory
P. J. Coleman, Univ. of Calif., Los Angeles
L. Davis, Calif. Institute of Technology
D. E. Jones, Brigham Young Univ.

PARAMETER: Field strength

EXPERIMENT: Study spatial and temporal changes in
the interplanetary magnetic field.
Measure field at Mars.

TECHNIQUE: Triaxial magnetometer

INSTRUMENT: Helium magnetometer

DISCIPLINE: Particles & Fields (prime)
Planetology

SPACE PROBES

PROJECT

DESIGNATION: Mariner C and D (Contd)

EXPERIMENTERS: H. V. Neher, Calif. Institute of Technology
H. R. Anderson, Jet Propulsion Laboratory

PARAMETER: Ionization rate

EXPERIMENT: Study temporal and spatial variations in
ionizing radiation

TECHNIQUE: Ion chamber and GM tube

INSTRUMENT: Ion chamber and GM tube

DISCIPLINE: Particles & Fields

EXPERIMENTERS: H. S. Bridge, Mass. Institute of Technology
A. J. Lazurus, Mass. Institute of Technology
C. W. Snyder, Jet Propulsion Laboratory

PARAMETER: Energy spectrum of low energy plasma

EXPERIMENT: Determine the temporal and spatial
variations in the energy and direction
spectra of the solar plasma

TECHNIQUE: Three element collector

INSTRUMENT: Plasma probe

DISCIPLINE: Particles & Fields

SPACE PROBES

PROJECT

DESIGNATION: Mariner C and D (Contd)

EXPERIMENTERS: W. M. Alexander, GSFC
O. E. Berg, GSFC
J. L. Bohn, Temple Univ.
O. Fuchs, Temple Univ.
C. W. McCracken, GSFC
L. Secretan, GSFC

PARAMETER: Intensity and frequency of impacts

EXPERIMENT: Measure mass and number of dust particles
in space and in the vicinity of Mars

TECHNIQUE: Particles hit plate and are recorded by
microphone and by capacitance change

INSTRUMENT: Plate with microphone and thin film
capacitors.

DISCIPLINE: Planetary Atmospheres (prime)
Planetology

SPACE PROBES

PROJECT

DESIGNATION: , Mariner C and D (Contd)

EXPERIMENTERS: J. A. Van Allen, State Univ. of Iowa
L. A. Frank, State Univ. of Iowa
S. M. Krimigis, State Univ. of Iowa

PARAMETER: Measure particles in several energy
ranges and in several directions

EXPERIMENT: Search for trapped particles at Mars.
Monitor solar cosmic rays and energetic
electrons in space.

TECHNIQUE: Detectors having different particle energy
thresholds and pointed in different
directions

INSTRUMENT: Anton 213 GM and P-N detectors

DISCIPLINE: Particles & Fields

EXPERIMENTER: J. A. Simpson, Univ. of Chicago

PARAMETER: Proton and alpha particle intensities

EXPERIMENT: Monitor cosmic rays and determine
gradients in protons and alphas

TECHNIQUE: Telescope with solid state detectors

INSTRUMENT: Telescope with solid state detectors

DISCIPLINE: Particles & Fields

SPACE PROBES

PROJECT
DESIGNATION: Pioneer A and B

VEHICLE: Thor Delta

DATE/SITE: 1965/AMR

TRAJECTORY: Earth escape

EXPECTED
LIFETIME: 6 months

HEADQUARTERS
CONTACT: J. Weldon
Alternate: G. Reiff

EXPERIMENTER: N. F. Ness, GSFC

PARAMETER: Magnetic field strength

EXPERIMENT: Monitor the magnetic field in inter-
planetary space

TECHNIQUE: Single sensor mounted $54^{\circ}45'$ to spin axis
and read out three times per revolution
determines vector field

INSTRUMENT: Fluxgate magnetometer

DISCIPLINE: Particles & Fields

SPACE PROBES

PROJECT

DESIGNATION: Pioneer A and B (Contd.)

EXPERIMENTER: H. Bridge, Mass. Institute of Technology

PARAMETER: Energy and direction spectra of plasma

EXPERIMENT: Monitor the energy and direction spectra of the plasma in interplanetary space

TECHNIQUE: Split collector used to determine direction. Voltage sweep used to determine energy spectra.

INSTRUMENT: Faraday cup with split collector, electrometer detector

DISCIPLINE: Particles & Fields

EXPERIMENTER: J. Simpson, Univ. of Chicago

PARAMETER: Measure independently the proton and alpha fluxes

EXPERIMENT: Monitor and determine the gradients in cosmic ray proton and alpha fluxes and hence determine the modulating effects of magnetic fields

TECHNIQUE: Uses energy loss, particle range and total energy to distinguish between protons and alphas

INSTRUMENT: Three solid state detectors mounted inside of an anti-coincidence phoswich scintillator

DISCIPLINE: Particles & Fields

SPACE PROBES

PROJECT

DESIGNATION: Pioneer A and B (Contd.)

EXPERIMENTER: V. Eshleman, Stanford University

PARAMETER: Changes in and total content of integrated electron content

EXPERIMENT: Determine the variations in the total electron content in the region of space between Pioneer and Earth

TECHNIQUE: Signals are transmitted from earth at 50 and 400 mc/s. Receivers on the spacecraft are used to compare frequencies and phase shifts.

INSTRUMENT: Two receivers, 50 and 400 mc/s, and associated electronics.

DISCIPLINE: Ionospheres & Radio Physics

EXPERIMENTER: J. Wolfe, Ames Research Center

PARAMETER: Energy and direction spectra of plasma

EXPERIMENT: Monitor the energy and direction spectra of the plasma in interplanetary space

TECHNIQUE: Eight plate collector to determine direction. Voltage sweep to determine energy spectra.

INSTRUMENT: Eight plate quadraspherical collector with electrometer detector.

DISCIPLINE: Particles & Fields

SPACE PROBES

PROJECT

DESIGNATION: Pioneer A and B (Contd.)

EXPERIMENTER: D. Gault, Ames Research Center

PARAMETER: Character and frequency of impacts

EXPERIMENT: Measure momentum, size, direction and distribution of dust particles in interplanetary space.

TECHNIQUE: Particles impact momentum transducer and simultaneously penetrate cadmium-sulfide surface, measuring momentum and size directly.

INSTRUMENT: Piezoelectric momentum transducer combined with a cadmium-sulfide detector

DISCIPLINE: Planetary Atmospheres

EXPERIMENTER: K. G. McCracken, Graduate Research Center of the Southwest, Dallas, Texas

PARAMETER: Count protons and alphas in each of four quadrants

EXPERIMENT: Determine the anisotropy of the low energy portion of the cosmic radiation

TECHNIQUE: Counts of protons and alphas are made in four quadrants

INSTRUMENT: Thick CsI crystal surrounded by a plastic scintillator. Photo multiplier with pulse height analysis.

DISCIPLINE: Particles & Fields

OTHER FLIGHT EXPERIMENTS

VEHICLE: Balloon

DATE/SITE: November 1963, Glen Canyon, Arizona

TRAJECTORY: Maximum altitude 130,000 feet

DURATION: 10 hours at altitude

HEADQUARTERS

CONTACT: Henry Smith
Alternate: Eugene Ehrlich

EXPERIMENTER: M. Kaplon

CONTRACTOR/
AGENCY: University of Rochester, Rochester, N.Y.

PARAMETER: The L group of nuclei ($3 \leq Z \leq 5$),
relativistic particles ($\beta \geq 0.72$),
protons corresponding to $\beta > 0.35$

EXPERIMENT: A charged particle detector sensitive
to relativistic particles.

TECHNIQUE AND
INSTRUMENT: A counter telescope consisting of a
scintillator followed by a Cerenkov
radiator.

DISCIPLINE: Solar Physics (prime)
Particles & Fields

OTHER FLIGHT EXPERIMENTS

VEHICLE: Balloon

DATE/SITE: December 1963, Palestine, Texas

TRAJECTORY: Maximum altitude 123,000 feet

DURATION: 36 hours at altitude

HEADQUARTERS

CONTACT: J. Freeman
Alternate: E. Ehrlich

EXPERIMENTER/
INVESTIGATOR: T. Parnell

CONTRACTOR/
AGENCY: University of North Carolina
Chapel Hill, North Carolina

PARAMETER: High energy cosmic rays

EXPERIMENT: Determine the charge spectrum of
primary cosmic rays of energy greater
than 1 Bev.

TECHNIQUE AND
INSTRUMENT: This experiment employs a high pressure
gas Cerenkov detector. The balloon
flight is intended as the first phase
of the development of the detector for
eventual satellite use.

DISCIPLINE: Particles & Fields

OTHER FLIGHT EXPERIMENTS

VEHICLE: Balloon

DATE/SITE: February 1964, Palestine, Texas

TRAJECTORY: To 130,000 feet

DURATION: 12 hours at altitude

HEADQUARTERS

CONTACT: N. Roman
Alternate: E. Ehrlich

EXPERIMENTER/
INVESTIGATOR: James Overbeck, MIT

PARAMETER: Anisotropy of gamma rays from 3 to 30 Mev

EXPERIMENT: Because of the recent discovery by Giacconi and others at American Science and Engineering of an intense source of soft x-rays in the general direction of the constellation Scorpio it becomes important to look for the anisotropy of gamma rays in a previously neglected energy region, viz. 3 to 30 Mev. Of the published mechanisms for the production of cosmic x-rays the Compton mechanism appears to be the one most promising. It requires transient (30,000 years) electron density such as is found in super nova remnants. It also implies the copious production of Bremsstrahlung gamma rays near 10 Mev; therefore, a search for these gamma rays should provide a crucial test for this experiment. Assuming the Compton effect is the x-ray generating mechanism it should be possible to detect the anisotropy of a gamma ray if the matter density in the source region is greater than 0.01 protons per cubic centimeter.

OTHER FLIGHT EXPERIMENTS

VEHICLE: Balloon (Contd.)

TECHNIQUE: Fly the gamma ray detector in a balloon so that it arrives at altitude at approximately 4:00 a.m. local standard time plus four minutes times the number of days since January 1. It would be helpful if the ascent from 10 to 3 millibars took place over one-half hour. It is permissible to make the ascent in two or three discreet steps. The balloon would have to be controlled in altitude to a tolerance of ± 1.5 millibars. The minimum acceptable altitude is 6 millibars.

DISCIPLINE: Astronomy (prime)
Solar Physics

OTHER FLIGHT EXPERIMENTS

VEHICLE: Balloon

DATE/SITE: Spring 1964, Palestine, Texas

TRAJECTORY: 100,000 feet

DURATION: 10 hours at altitude

HEADQUARTERS
CONTACT: Henry Smith
Alternate: Eugene Ehrlich

EXPERIMENTER/
INVESTIGATOR: Gordon Newkirk

CONTRACTOR/
AGENCY: University Corporation for Atmospheric
Research
Boulder, Colorado

PARAMETER: Solar corona

EXPERIMENT: To record the intensity, degree of
polarization, and polarization angle
of coronal light from a few minutes
of the solar limb to about 6 solar
radii. Flight test of a coronagraph
and study of the solar corona.

TECHNIQUE AND
INSTRUMENT: The coronagraph simulates an eclipse of
the sun and records data on the corona.

DISCIPLINE: Solar Physics (prime)
Astronomy

OTHER FLIGHT EXPERIMENTS

VEHICLE: Balloon

DATE/SITE: Summer 1964/Fort Churchill, Canada

TRAJECTORY: Altitude near 150,000 feet

DURATION: 12 hours at altitude

HEADQUARTERS

CONTACT: E. Ehrlich
Alternate: J. Freeman

EXPERIMENTER/
INVESTIGATOR: Kinsey Anderson

CONTRACTOR/
AGENCY: University of California, Berkeley, Calif.

PARAMETER: Auroral zone X-rays and electrons.

EXPERIMENT: Study of electron precipitation in the
auroral zone.

TECHNIQUE AND
INSTRUMENT: Balloon-borne scintillation counters.

DISCIPLINE: Particles & Fields

OTHER FLIGHT EXPERIMENTS

VEHICLE: Balloon

DATE/SITE: Summer 1964/Ft. Churchill, Canada and
Minneapolis

TRAJECTORY: 135,000 ft. altitude

DURATION: 12 hours at altitude

HEADQUARTERS

CONTACT: J. Freeman
Alternate: E. Ehrlich

EXPERIMENTER/
INVESTIGATOR: J. R. Winckler
W. R. Webber
C. Waddington

CONTRACTOR/
AGENCY: University of Minnesota
Minneapolis, Minn.

PARAMETER: Cosmic rays and auroral precipitations

EXPERIMENT: The experiment is designed to measure the charge and energy spectra of cosmic rays at several geomagnetic latitudes during the solar minimum period. Also included in the Univ. of Minn. balloon studies are measurements of auroral X-rays.
These experiments are closely correlated with rocket and satellite experiments conducted at the Univ. of Minn. under the same grant.

TECHNIQUE: Nuclear emulsions, Geiger counters, scintillation counters, Cerenkov counters and cloud chambers

DISCIPLINE: Particles & Fields (prime)
Solar Physics

OTHER FLIGHT EXPERIMENTS

VEHICLE: Balloon

DATE/SITE: Summer 1964/Ft. Churchill, Canada

TRAJECTORY: Altitude of 135,000 feet

DURATION: 12 - 18 hours at altitude

HEADQUARTERS

CONTACT: J. Freeman
Alternate: E. Ehrlich

EXPERIMENTER/
INVESTIGATOR: K. G. McCracken

CONTRACTOR/
AGENCY: Graduate Research Center of the Southwest

PARAMETER: Cosmic ray directionality

EXPERIMENT: Investigation of cosmic radiation
anisotropies.

TECHNIQUE AND
INSTRUMENT: Using a balloon-borne cosmic ray scintil-
lation counter telescope, measurements
will be made of the primary cosmic ray
flux at low latitudes.

DISCIPLINE: Particles & Fields

OTHER FLIGHT EXPERIMENTS

VEHICLE: Balloon

DATE/SITE: Summer 1964/Ft. Churchill, Canada and
Palestine, Texas

TRAJECTORY: Altitude above 125,000 feet

DURATION: 12 hours at altitude

HEADQUARTERS
CONTACT: J. Freeman
Alternate: E. Ehrlich

EXPERIMENTER/
INVESTIGATOR: Peter Meyer
C. Y. Fan

CONTRACTOR/
AGENCY: University of Chicago
Enrico Fermi Institute for Nuclear Studies
Chicago, Ill.

PARAMETER: Primary cosmic ray electrons, positrons,
protons and alpha particles.

EXPERIMENT: To determine the variations in the flux
and energy spectra of the above particles
at different intervals during a complete
solar cycle.

TECHNIQUE AND
INSTRUMENT: The various detectors to be employed
include a scintillation telescope, a
Cerenkov telescope and a spark chamber
with a large high field magnet.

DISCIPLINE: Particles & Fields

OTHER FLIGHT EXPERIMENTS

VEHICLE: Balloon

DATE/SITE: About six(6) balloon flights a year from Palestine, Texas

TRAJECTORY: To 100,000 ft. altitude

DURATION: Several hours at altitude

HEADQUARTERS

CONTACT: M. Dubin
Alternate: E. Ehrlich

EXPERIMENTER/
INVESTIGATOR: C. Hemenway, Dudley Observatory

PARAMETER: Micrometeorite concentration and size distribution in the atmosphere. Chemical structure of micrometeorites.

EXPERIMENT: Investigate the chemical structure, terrestrial accretion rate, and mass distribution of interplanetary material collected at balloon altitudes.

DISCIPLINE: Planetary Atmospheres (prime)
Planetology

OTHER FLIGHT EXPERIMENTS

PROJECT

DESIGNATION: X-15 Scientific Program

VEHICLE: X-15 No. 2

DATE/SITE: 1964/Flight Research Center

TRAJECTORY: 80 km (approx.)

DURATION: 20 minutes (approx.)

HEADQUARTERS

CONTACT: E. J. Ott

Alternate: J. A. Martin (RA)

EXPERIMENTER: A. D. Code, Univ. of Wisconsin

PARAMETER: Sky brightness

EXPERIMENT: Measure relative brightness of sky and
earth backgroundTECHNIQUE: Photometer looks aft during X-15 flight
and sees earth, earth-sky, and sky
successively

INSTRUMENT: Photometer

DISCIPLINE: Astronomy

OTHER FLIGHT EXPERIMENTS

PROJECT

DESIGNATION: X-15

VEHICLE: X-15 No. 2 airplane

DATE/SITE: Indefinite/Flight Research Center

TRAJECTORY: Max altitude varies; 80 km is a currently typical value

DURATION: (a) Flight time approx. 20 min.
(b) At "top" of ballistic trajectory approx. 8 min.

HEADQUARTERS

CONTACT: E. J. Ott
Alternate: J. A. Martin (RA)EXPERIMENTER: A. D. Code, Univ. of Wisconsin
T. Houck, Univ. of Wisconsin
T. Bless, Univ. of Wisconsin
J. McNall, Univ. of Wisconsin
D. Schroeder, Univ. of Wisconsin

PARAMETER: Stellar UV radiation in the region about 1800-4200Å

EXPERIMENT: Photographic photometry over a 10° star field in the UV of bright, early type stars

TECHNIQUE AND

INSTRUMENT: Use four cameras with reflecting optics and UV filters to record stellar brightness on UV photographic film. The cameras to be mounted on a gyro stabilized platform. Three of the cameras are designed to have passes of $\pm 150^\circ$ and are responsive to 2100, 2600, and 4200Å respectively. The fourth employs an objective grating to record the stellar spectra in the region 1800-3000Å.

DISCIPLINE: Astronomy

GEOPROBES AND SOUNDING ROCKETS

NASA NO.: None

VEHICLE: ARCAS (2 vehicles)

DATE/SITE: 1963/New Zealand

TRAJECTORY: 80 km

HEADQUARTERS
CONTACT: R. F. Fellows
Alternate: J. Holtz

EXPERIMENTER: P. Gregory, Univ. of Canterbury, New Zealand

PARAMETER: Winds, wind shears, D region radio scattering characteristics

EXPERIMENT: Measure correlation with RF radar information of shears and turbulence in the 60 to 90 km region

TECHNIQUE: Release particles from rocket and photograph time-dependent dispersion to determine winds and shears

INSTRUMENT: Particle disperser and photographic equipment

DISCIPLINE: Planetary Atmospheres (prime)
Ionospheres & Radio Physics

GEOPROBES AND SOUNDING ROCKETS

NASA NO.: None

VEHICLE: ARCAS, LOKI II, and HASP

DATE/SITE: CY 1963 (about 100 flights per year),
Wallops Island, Va., Cape Canaveral, Fla.,
Ft. Churchill, Canada, etc.

TRAJECTORY: Under 80 km

HEADQUARTERS

CONTACT: W. C. Spreen
Alternate: M. Dubin

EXPERIMENTER: H. B. Tolefson, MSFC
W. W. Vaughn, MSFC
A. Taiani, MSFC
H. N. Murrow, Langley

PARAMETER: Winds, wind shear, temperature, density
of the atmosphere

EXPERIMENT: NASA support of Project IRIG. Synoptic
measuring program using small rockets
in the altitude range from 30 to 80 km
to map the structure of the atmosphere
above balloon altitudes.

TECHNIQUE: Synoptic firings of small rockets from
six or more sites

INSTRUMENT: Chaff, falling spheres, parachutes with
thermistors

DISCIPLINE: Meteorology (prime)
Planetary Atmospheres

GEOPROBES AND SOUNDING ROCKETS

NASA NO.: 4.22

VEHICLE: Aerobee

DATE/SITE: Sept. 1963/Wallops Island

TRAJECTORY: 200 km

HEADQUARTERS
CONTACT: H. J. Smith

EXPERIMENTER: W. Liller, Harvard Univ.

PARAMETER: Solar UV spectrum and instrument

EXPERIMENT: Make another flight test of solar UV experiment for OSO-B satellite. To measure intensity of radiation coming from the Sun in the 500-1500Å wavelength region.

TECHNIQUE: Direct solar radiation is focused by a concave mirror at the entrance of the slit of the Johnson Onaketype spectrometer. By rotating the concave diffraction grating the spectrum is scanned across a photomultiplier.

INSTRUMENT: Spectrograph

DISCIPLINE: Solar Physics

GEOPROBES AND SOUNDING ROCKETS

NASA NO.: 4.24

VEHICLE: Aerobee

DATE/SITE: 4Q1963/Wallops Island

TRAJECTORY: 200 km

HEADQUARTERS

CONTACT: H. J. Smith

Alternate: R. E. Halpern

EXPERIMENTER: W. A. Rense, Univ. of Colorado

PARAMETER: Solar spectrum 50 - 1500Å

EXPERIMENT: Measure the energy of the solar spectrum
between about 50 and 1500Å

TECHNIQUE: Scan spectrum in region 50 - 1500Å
utilizing a plane grating concave mirror
grazing incidence spectrograph

DISCIPLINE: Solar Physics

GEOPROBES AND SOUNDING ROCKETS

NASA NO. 4.45

VEHICLE: Aerobee 150A

DATE/SITE: 1Q1964/Wallops Island

TRAJECTORY: 230 km peak altitude

HEADQUARTERS

CONTACT: A. G. Opp
Alternate: J. R. Holtz

EXPERIMENTER: S. J. Bauer, GSFC
H. A. Whale, GSFC

PARAMETER: Electron density

EXPERIMENT: Comparison of different techniques for
measuring electron density, and investi-
gation of electroacoustic mode

TECHNIQUE AND
INSTRUMENT: C. W. propagation, RF probe, electro-
acoustic probe, swept frequency probe,
Langmuir probe.

DISCIPLINE: Ionospheres & Radio Physics

GEOPROBES AND SOUNDING ROCKETS

NASA NO.: 4.50, 4.51, 4.52

VEHICLE: Aerobee 150A

DATE/SITE: 4.50, 4.51 2Q64/White Sands
4.52 1964/Wallops Island

HEADQUARTERS

CONTACT: N. G. Roman

Alternate: J. R. Holtz

EXPERIMENTER: J. Rogerson, Princeton Univ.

PARAMETER: Stellar spectra of selected stars

EXPERIMENT: Observe stellar spectra by pointing a spectrometer at the hot star Pegasi to study its ultraviolet radiation with moderate dispersion. Wavelengths to be studied are 3230\AA to 1730\AA in first order with a resolution of 2\AA , and 1615\AA to 865\AA in second order with resolution of 1\AA .

TECHNIQUE: Payload is inertially pointed to the desired star and then servo-controlled. An objective grating telescope is precisely pointed to target and grating turns to scan desired spectral region.

INSTRUMENT: Detectors: An EMI photomultiplier for first range (3230 to 1730\AA). Bendix magnetic photomultiplier for lower range (1615 to 865\AA).

DISCIPLINE: Astronomy

GEOPROBES AND SOUNDING ROCKETS

NASA NO.: 4.64, 4.65

VEHICLE: Aerobee 150A

DATE/SITE: 3Q63/Wallops

TRAJECTORY: 225 km peak altitude

HEADQUARTERS

CONTACT: A. G. Opp
Alternate: J. R. Holtz

EXPERIMENTER: G. P. Serbu, GSFC
Radio Research Laboratories, Japan

PARAMETER: Charged-particle concentration and
temperature distribution as a function
of altitude.

EXPERIMENT: Joint U. S. - Japanese experiment in
the lower ionosphere to investigate the
processes occurring in the lower iono-
sphere and to cross-check different
measuring techniques.

TECHNIQUE: Use of two independent experimental
techniques for simultaneous comparison
of the above mentioned parameters

INSTRUMENT: Composite electron and ion trap and
resonance probe.

DISCIPLINE: Ionospheres & Radio Physics

GEOPROBES AND SOUNDING ROCKETS

NASA NO.: 4.67

VEHICLE: Aerobee 150A

DATE/SITE: 1963/White Sands Proving Ground, N.M.

TRAJECTORY: To 200 km

HEADQUARTERS

CONTACT: C. D'Aintolo
Alternate: M. Dubin

EXPERIMENTER: R. W. Hopko, Langley Research Center
W. H. Kinard, Langley Research Center

PARAMETER: Micrometeorite penetration rates and
hypervelocity effects

EXPERIMENT: Measurement of actual micrometeorite
penetration rate and depth on a large
area paraglider detector; determination
of effects by analysis of recovered
detectors. (Study paraglider performance).

TECHNIQUE: Rocket launching of large paraglider
covered with micrometeorite detectors.
Paraglider is recovered.

INSTRUMENT: Capacitance, multilayer penetration
detectors on recoverable paraglider

DISCIPLINE: Planetary Atmospheres

GEOPROBES AND SOUNDING ROCKETS

NASA NO.: 4.76

VEHICLE: Aerobee 150A

DATE/SITE: 4Q63/Wallops Island, Va.

TRAJECTORY: To 250 km

HEADQUARTERS

CONTACT: M. Dubin
Alternate: R. F. Fellows

EXPERIMENTER: W. Fastie, Johns Hopkins Univ.
G. H. Dieke, Johns Hopkins Univ.

PARAMETER: Airglow spectrum 1000 to 2400 \AA , and
atmospheric airglow

EXPERIMENT: Determination of the spectrum of the day
and night airglow in the ultraviolet and
the effects of latitude and energetic
particle excitations. Determination of
atmospheric composition and reaction
mechanisms.

TECHNIQUE: Direct measurement of spectrum of the
airglow and atmospheric fluorescence

INSTRUMENT: Fastie-Ebert spectrometer, photometers

DISCIPLINE: Planetary Atmospheres

GEOPROBES AND SOUNDING ROCKETS

NASA NO.: 4.83, 4.84

VEHICLE: Aerobee 150A

DATE/SITE: 1 and 2Q64/White Sands, New Mexico

TRAJECTORY: To 200 km

HEADQUARTERS

CONTACT: M. Dubin
Alternate: R. F. Fellows

EXPERIMENTER: L. Dunkelman, GSFC
J. P. Hennes, GSFC

PARAMETER: Spectral distribution and absolute intensity of the airglow from 1700⁰Å to 3200⁰Å.

EXPERIMENT: Determine airglow intensities as a function of altitude and derive composition (O₃, O₂, and O concentrations) and atomic and molecular reaction conditions. Extend techniques to Mars, Venus, and Jupiter.

TECHNIQUE: Measurement of altitude distribution of the night airglow with a spectrophotometer using a stable despun platform

INSTRUMENT: Spectrophotometer with photomultiplier and filters

DISCIPLINE: Planetary Atmospheres

GEOPROBES AND SOUNDING ROCKETS

NASA NO.: 4.85, 4.86

VEHICLE: Aerobee 150A

DATE/SITE: 4Q63/White Sands Proving Ground, N. M.
and Wallops Island, Va.

TRAJECTORY: To 150 km

HEADQUARTERS
CONTACT: R. Moore
Alternate: M. Dubin

EXPERIMENTER: C. A. Barth, Jet Propulsion Laboratory

PARAMETER: Spectrum of dayglow and atmospheric
composition

EXPERIMENT: Determination of the altitude variation
of the dayglow fluorescence spectrum in
region from 2000 to 3400Å and atmospheric
composition in the chemosphere.

TECHNIQUE: Measurement of the ultraviolet spectrum
of dayglow as a function of altitude

INSTRUMENT: Ebert-Fastie spectrometer with solar
blind photomultipliers

DISCIPLINE: Planetary Atmospheres

GEOPROBES AND SOUNDING ROCKETS

NASA NO. 4.94, 4.95

VEHICLE: Aerobee 150A

DATE/SITE: October 1963/Wallops Island

TRAJECTORY: 184 km

HEADQUARTERS

CONTACT: A. G. Opp
Alternate: J. R. Holtz

EXPERIMENTER: O. Storey

CONTRACTOR/
AGENCY: CNES/CNET, France

PARAMETER: Electric and magnetic field strengths
in the ionosphere

EXPERIMENT: Flights are part of the French satellite
program. Primary measurements are to be
made on the components of the VLF wave
field.

TECHNIQUE: Measurements will be made of three
orthogonal components of the VLF magnetic
field, two orthogonal components of the
VLF electric field, and the impedance of
the electric dipole

INSTRUMENT: VLF electric dipole tipped with four inch
diameter aluminum spheres. Test models
of satellite instruments.

DISCIPLINE: Ionospheres & Radio Physics

GEOPROBES AND SOUNDING ROCKETS

NASA NO.: 4.99, 4.100, 4.101

VEHICLE: Aerobee 150A

DATE/SITE: 1, 2, and 3Q64/Wallops Island
(concurrent with 8.25, 8.26)

TRAJECTORY: 200 km

HEADQUARTERS

CONTACT: A. G. Opp
Alternate: J. R. Holtz

EXPERIMENTER: H. E. Hinteregger, AFCRL

PARAMETER: EUV of aeronomical significance

EXPERIMENT: Rather than scanning a wide range of wavelengths a monochromator will record the photon fluxes as a modest number of different fixed wavelengths as continuously as possible.

TECHNIQUE: Continuously measure several fixed wavelengths in the EUV

INSTRUMENT: Aeronomical monochromator

DISCIPLINE: Ionospheres & Radio Physics (prime)
Planetary Atmospheres

GEOPROBES AND SOUNDING ROCKETS

NASA NO.: 4.113

VEHICLE: Aerobee 150

DATE/SITE: April 1964/White Sands

TRAJECTORY: To 150 km

HEADQUARTERS

CONTACT: A. Schardt
Alternate: M. Dubin

EXPERIMENTER: O. E. Berg, GSFC
C. Ailsen, GSFC
E. Whipple, GSFC

PARAMETER: Micrometeorite collection and altitude distribution, ion density, electron density and X-ray intensity in D region.

EXPERIMENT: Determine the altitude distribution, cratering effects, and chemical structure of micrometeorites in the lower ionosphere. Determine the associated ion and electron density distribution and X-ray intensity.

TECHNIQUE: Collect micrometeorites impacted on controlled surfaces and subsequently recovered. Ion and electrons profiles measured with probes. X-ray intensity relating to ion concentration also measured.

INSTRUMENT: Cylindrically shaped aluminized glass tube impactors. Moving film collectors. Langmuir probes. X-ray camera.

DISCIPLINE: Planetary Atmospheres (prime)
Ionospheres & Radio Physics

GEOPROBES AND SOUNDING ROCKETS

NASA NO.: 6.09, 6.10, 6.11, 6.12

VEHICLE: Aerobee 300

DATE/SITE: 4Q63, 1Q64, 2Q64, 3Q64/Wallops Island

TRAJECTORY: To 400 km

HEADQUARTERS

CONTACT: M. Dubin
Alternate: J. Holtz

EXPERIMENTER: L. H. Brace, GSFC

PARAMETER: Pressure, partial pressures, density,
temperature, ion and electron density,
ion and electron temperature.

EXPERIMENT: Determine altitude profile of atmospheric
structure parameters and ionic content
and determine function of diurnal-,
seasonal-, or latitude-dependence.

TECHNIQUE: Series of rocket firing of ejected
packages containing a combination of
instruments.

INSTRUMENT: Pressure gauges, Omegatron ion probe

DISCIPLINE: Planetary Atmospheres

GEOPROBES AND SOUNDING ROCKETS

NASA NO.: 8.03

VEHICLE: Javelin

DATE/SITE: 1963/Wallops Island

TRAJECTORY: To 200 km, to 1000 km

HEADQUARTERS
CONTACT: M. Dubin

EXPERIMENTER: G. Sharp, Lockheed
D. McKibben, Lockheed

PARAMETER: Composition of ions, ion density, ion
temperature

EXPERIMENT: Determination of composition, density,
and energy distribution of the atmosphere
to 1000 km

TECHNIQUE: Direct measurements with ion probes and
mass spectrometers

INSTRUMENT: Paul Massenfilter, magnetic mass spectrom-
eter, ion probe

DISCIPLINE: Planetary Atmospheres (prime)
Ionospheres & Radio Physics

GEOPROBES AND SOUNDING ROCKETS

NASA NO.: 8.18

VEHICLE: Argo D-4

DATE/SITE: 3Q63/Wallops Island

TRAJECTORY: 1000 km

HEADQUARTERS

CONTACT: A. G. Opp
Alternate: J. R. Holtz

EXPERIMENTER: R. W. Knecht, Central Radio Propagation Lab.
National Bureau of Standards
S. Russell, Airborne Instruments Lab.

PARAMETER: Electron density, radio noise

EXPERIMENT: To elucidate problems connected with the
interpretation of topside sounder data.
Tests of next generation topside sounder
techniques.

TECHNIQUE AND
INSTRUMENT: Swept frequency radio transmitter and
receiver

DISCIPLINE: Ionospheres & Radio Physics

GEOPROBES AND SOUNDING ROCKETS

NASA NO.: 8.19, 8.20

VEHICLE: Argo D-4

DATE/SITE: 2Q64/Ft. Churchill

TRAJECTORY: 980 km peak altitude

HEADQUARTERS

CONTACT: A. G. Opp
Alternate: J. R. Holtz

EXPERIMENTER: A. Nagy, Univ. of Michigan in collaboration
with Ballistics Research Laboratory

PARAMETER: Electron density, ion density, electron
temperature, magnetic field

EXPERIMENT: To measure above parameters in auroral
conditions

TECHNIQUE AND

INSTRUMENT: Cylindrical Langmuir probe, precession
magnetometer, CW propagation on 2 fre-
quencies

DISCIPLINE: Ionospheres & Radio Physics

GEOPROBES AND SOUNDING ROCKETS

NASA NO.: 8.25, 8.26

VEHICLE: Argo D-4

DATE/SITE: 3Q63 and 1Q64/Wallops

TRAJECTORY: 800 km peak altitude

HEADQUARTERS

CONTACT: A. G. Opp
Alternate: J. R. Holtz

EXPERIMENTER: R. E. Bourdeau, GSFC
N. W. Spencer, GSFC
S. J. Bauer, GSFC
H. A. Taylor, GSFC

PARAMETER: Densities of ions and electrons, neutral
densities, electron and ion temperatures

EXPERIMENT: In conjunction with a separate, simultaneous measurement of solar flux, to measure the individual quantities which enter into the continuity equation. Some cross-checking with Topside Sounder data is also planned.

TECHNIQUE AND
INSTRUMENT: CW propagation measurement
Planar and spherical ion probes
Retarding potential analyzer
Ionization gauge

DISCIPLINE: Ionospheres & Radio Physics (prime)
Planetary Atmospheres

GEOPROBES AND SOUNDING ROCKETS

NASA NO.: 8.28, 8.30

VEHICLE: Argo D-4

DATE/SITE: 4Q63/Wallops

TRAJECTORY: 1100 km peak altitude

HEADQUARTERS

CONTACT: A. G. Opp
Alternate: J. R. Holtz

EXPERIMENTER: J. S. Nisbet, Pennsylvania State Univ.

PARAMETER: Electron density

EXPERIMENT: Accurate determination of electron density profile by radio wave propagation between rocket and separating capsule.

TECHNIQUE: Propagation of signals between rocket and capsule

INSTRUMENT: Receivers, transmitters, phase comparators

DISCIPLINE: Ionospheres & Radio Physics

GEOPROBES AND SOUNDING ROCKETS

NASA NO.: 8.31, 8.32

VEHICLE: Argo D-4

DATE/SITE: December 1963/Wallops Island
3Q64/Wallops Island

TRAJECTORY: 1200 km

HEADQUARTERS

CONTACT: M. Dubin
Alternate: J. Holtz

EXPERIMENTER: C. Y. Johnson
J. Hoffman
P. W. Mange

CONTRACTOR/
AGENCY: Naval Research Laboratory

PARAMETER: Ion composition, airglow densities of oxygen
6300 Å, and Lyman alpha.

EXPERIMENT: Measure related altitude profiles of
ion composition and oxygen and hydrogen
airglow for comparison of neutral and
ionic species and determination of their
distributions.

TECHNIQUE: Measure altitude profile during the night
of ionic constituents and airglow

INSTRUMENT: Bennett or magnetic mass spectrometers,
photometer and ion chamber.

DISCIPLINE: Planetary Atmospheres (prime)
Ionospheres & Radio Physics

GEOPROBES AND SOUNDING ROCKETS

NASA NO.: 10.54 - 10.55; 10.61; 10.62, 10.63;
10.71, 10.73 - 10.74; 10.86 - 10.89

VEHICLE: Nike-Cajun

DATE/SITE: 1963 (12 rockets), Wallops Island, Va.
and Ft. Churchill, Canada

TRAJECTORY: To 100 km

HEADQUARTERS

CONTACT: W. C. Spreen
Alternate: M. Dubin

EXPERIMENTER: W. Nordberg, GSFC
W. Smith, GSFC

PARAMETER: Wind velocity and atmospheric temperature

EXPERIMENT: Measurement of wind and temperature profiles between 30 and 95 km to investigate seasonal, geographical, and diurnal patterns and their causes

TECHNIQUE: Trace sound ray paths from up to twelve grenade explosions in the 30 to 95 km altitude interval. Simultaneous firing of rockets from more than one site and time spaced firings.

INSTRUMENT: Grenades in conjunction with ground array of acoustic detectors

DISCIPLINE: Meteorology (prime)
Planetary Atmospheres

GEOPROBES AND SOUNDING ROCKETS

NASA NO.: To be assigned

VEHICLE: Nike-Cajun (4)

DATE/SITE: 1964/Wallops Islnd, Va.

TRAJECTORY: To 150 km

HEADQUARTERS

CONTACT: H. F. Hipsher
Alternate: R. F. Fellows

EXPERIMENTER: R. Hord, Langley Research Center

PARAMETER: Chemiluminescent reaction rates, atmospheric motions

EXPERIMENT: Determination of atmospheric motion during darkness, and the study of chemiluminescent reaction efficiencies

TECHNIQUE: Release of reactive gases in the atmosphere

INSTRUMENT: Ground photography and photometers

DISCIPLINE: Planetary Atmospheres

GEOPROBES AND SOUNDING ROCKETS

NASA NO.: To be assigned

VEHICLE: Nike-Cajun or other - piggybacks

DATE/SITE: 1963 (between 2 and 20) Wallops Island
/1963 (10) - Kwajalein/

TRAJECTORY: To 130 km

HEADQUARTERS

CONTACT: M. Dubin
Alternate: W. C. Spreen

EXPERIMENTER: L. M. Jones, Univ. of Michigan
L. Peterson, Univ. of Michigan

PARAMETER: Atmospheric density, temperature and
winds

EXPERIMENT: Systematic measurements of atmospheric
structure and its variations with time
of day and season from 110 km and below,
using sphere drag

TECHNIQUE: Determination of atmospheric drag and
lateral position by radar tracking a
falling sphere

INSTRUMENT: Mylar sphere and hi-power radar

DISCIPLINE: Planetary Atmospheres (prime)
Meteorology (prime)

GEOPROBES AND SOUNDING ROCKETS

NASA NO.: 11.03

VEHICLE: Argo D-8

DATE/SITE: 1964/Wallops Island

TRAJECTORY: About 1800 km

HEADQUARTERS

CONTACT: E. J. Ott
Alternate: N. G. Roman

EXPERIMENTER: F. T. Haddock, Univ. of Michigan
D. Walsh, Univ. of Michigan
H. F. Shulte, Univ. of Michigan

PARAMETER: Radio background noise

EXPERIMENT: Determine cosmic radio background noise
at several fixed frequencies between
about 0.75 and 2 Mc/s

TECHNIQUE: Three fixed frequency radio receivers
with deHavilland antennae observe the sky
for radio emissions. A preprogrammed
mode of observations and calibrations is
provided.

INSTRUMENT: Fixed frequency receiver

DISCIPLINE: Astronomy

GEOPROBES AND SOUNDING ROCKETS

NASA NO.: 14.06, 14.07, 14.79 through 14.85

VEHICLE: Nike-Apache

DATE/SITE: 3Q63, 1, 2, 3Q/64/Equatorial Launch Site,
India

TRAJECTORY: 160-180 km

HEADQUARTERS

CONTACT: A. G. Opp
Alternate: J. Holtz

EXPERIMENTER: L. J. Cahill, Univ. of New Hampshire
A. White, Univ. of New Hampshire

PARAMETER: Magnetic field

EXPERIMENT: The structure and intensity of the
equatorial electrojet current in the
ionosphere will be measured.

TECHNIQUE: Determination of electric current density
through measurement of magnetic field
produced by current.

INSTRUMENT: Proton precession magnetometer

DISCIPLINE: Particles & Fields (prime)
Ionospheres & Radio Physics

GEOPROBES AND SOUNDING ROCKETS

NASA NO.: 14.10, 14.11

VEHICLE: Nike Apache

DATE/SITE: March 1964/Wallops Island/Ft. Churchill

TRAJECTORY: To 200 km

HEADQUARTERS

CONTACT: M. Dubin
Alternate: R. Horowitz

EXPERIMENTER: E. Schaefer, Univ. of Michigan
L. M. Jones, Univ. of Michigan

PARAMETER: Atmospheric composition-relative and absolute concentrations of neutral and ionic constituents for each SMU.

EXPERIMENT: Determination of the chemical and ionic composition of the atmosphere and the generation and loss mechanisms of atmospheric constituents. Measurement of atmospheric structure variations as affected by solar radiation and particle bombardment.

TECHNIQUE: Measurements of the altitude profile of composition and determination of diurnal and latitude variations

INSTRUMENT: Paul Massenfilter mass spectrometer

DISCIPLINE: Planetary Atmospheres (prime)
Ionospheres & Radio Physics

GEOPROBES AND SOUNDING ROCKETS

NASA NO.: 14.22 - 14.25

VEHICLE: Nike-Apache

DATE/SITE: 1963/Wallops Island, Va. and Ft. Churchill,
Canada

TRAJECTORY: To 150 km

HEADQUARTERS

CONTACT: M. Dubin
Alternate: R. Horowitz

EXPERIMENTER: J. Horvath, Univ. of Michigan

PARAMETER: Pressure, temperature, density and
winds to 140 km

EXPERIMENT: Investigation of atmospheric structure
parameters especially for diurnal de-
pendence above 100 km

TECHNIQUE: Pitot-static configuration of pressure
gauges on rocket probes, to determine
pressure, and derive density, temperature
and winds.

INSTRUMENT: Pressure gauges

DISCIPLINE: Planetary Atmospheres

GEOPROBES AND SOUNDING ROCKETS

NASA NO.: 14.33, 14.34

VEHICLE: Nike-Apache

DATE/SITE: 4Q63/Wallops Island

TRAJECTORY: 160 km peak altitude

HEADQUARTERS
CONTACT: A. G. Opp
Alternate: J. R. Holtz

EXPERIMENTER: S. J. Bauer, GSFC

PARAMETER: Electron density, solar flux

EXPERIMENT: E region study to correlate flux measurements with measurements of electron density

TECHNIQUE: CW propagation, ion probe

INSTRUMENT: Simple radiation detector

DISCIPLINE: Ionospheres & Radio Physics

GEOPROBES AND SOUNDING ROCKETS

NASA NO.: 14.37

VEHICLE: Nike Apache

DATE/SITE: December 1963/White Sands

TRAJECTORY: 190 km

HEADQUARTERS

CONTACT: A. G. Opp
Alternate: J. R. Holtz

EXPERIMENTER: E. C. Whipple, GSFC

PARAMETER: Ion and electron densities; also electrical conductivity

EXPERIMENT: D region investigation - simultaneous measurement of a number of parameters in an effort to investigate the processes which produce the D region.

TECHNIQUE: Propagation experiment, Faraday rotation, ionization measurements.

INSTRUMENT: Gerdien condenser, ionization chamber, transmitter

DISCIPLINE: Ionospheres & Radio Physics

GEOPROBES AND SOUNDING ROCKETS

NASA NO.: 14.43 - 14.44, 14.118 - 14.120

VEHICLE: Nike Apache

DATE/SITE: February-March 1964/Ft. Churchill

TRAJECTORY: 200 km

HEADQUARTERS

CONTACT: J. Freeman
Alternate: J. Holtz

EXPERIMENTER: D. L. Evans, GSFC

PARAMETER: Auroral radiation

EXPERIMENT: Measurement of the high latitude auroral radiation using zero wall thickness detectors

TECHNIQUE: Rocket measurement of precipitating auroral particles.

INSTRUMENT: Capillary tube electron multiplier charged particle detectors.

DISCIPLINE: Particles & Fields

GEOPROBES AND SOUNDING ROCKETS

NASA NO.: 14.102, 14.103

VEHICLE: Nike-Apache

DATE/SITE: 4Q1963/Wallops Island

TRAJECTORY: Peak altitude 150 km or higher

HEADQUARTERS
CONTACT: H. F. Hipsher

EXPERIMENTER: A. E. Potter, Lewis Research Center

PARAMETER: Reaction rates, intensity of solar induced resonance radiation and persistence of chemical clouds.

EXPERIMENT: To generate a cloud of CN, C₃, etc. free radicals at an altitude above 100 km by a chemical reaction between ClF₃ and compounds such as cyanogen or benzene. The major purpose of the experiment is to simulate some of the features of comets.

TECHNIQUE: The cloud is to be observed by ground photography and spectrophotometry after ejection from the rocket.

INSTRUMENT: Ground-based photometers and cameras.

DISCIPLINE: Planetary Atmospheres

GEOPROBES AND SOUNDING ROCKETS

NASA NO.: 14.104, 14.105

VEHICLE: Nike Apache

DATE/SITE: 2Q64/Ft. Churchill

TRAJECTORY: 200 km

HEADQUARTERS

CONTACT: A. G. Opp
Alternate: J. R. Holtz

EXPERIMENTER: G. R. Carignan, Univ. of Michigan in collaboration with Ballistics Research Laboratory

PARAMETER: Ionospheric plasma

EXPERIMENT: Particle fluxes will be measured by means of the Langmuir probe technique.

TECHNIQUE: Langmuir probe

INSTRUMENT: Langmuir probe

DISCIPLINE: Ionospheres & Radio Physics

GEOPROBES AND SOUNDING ROCKETS

NASA NO.: 14.109

VEHICLE: Nike-Apache

DATE/SITE: 2Q64/Wallops Island, or Norway

TRAJECTORY: 120 km peak altitude

HEADQUARTERS

CONTACT: A. G. Opp
Alternate: J. R. Holtz

EXPERIMENTER: E. C. Whipple, GSFC

PARAMENTER: Ion and electron densities; also
electrical conductivity; monitor solar
UV and X-ray emissions

EXPERIMENT: D region investigation - simultaneous
measurement of a number of parameters in
an effort to investigate the processes
which produce the D region

TECHNIQUE AND
INSTRUMENT: Gerdien condenser, Faraday rotation
propagation experiment, ionization
chambers

DISCIPLINE: Ionospheres & Radio Physics

GEOPROBES AND SOUNDING ROCKETS

NASA NO.: 14.121 - 14.124

VEHICLE: Nike Apache

DATE/SITE: March 1964/Ft. Churchill

TRAJECTORY: 200 km

HEADQUARTERS

CONTACT: J. W. Freeman
Alternate: J. R. Holtz

EXPERIMENTER: W. Murcary

CONTRACTOR/
AGENCY: Univ. of Alaska, College, Alaska

PARAMETER: Particle fluxes in auroral phenomena

EXPERIMENT: Experiments are to be designed, constructed and flown to measure auroral light, particle flux, and UV and gamma flux.

TECHNIQUE: Measurement of fluxes in various energy ranges

INSTRUMENT: Shielded and unshielded scintillators

DISCIPLINE: Particles & Fields

GEOPROBES AND SOUNDING ROCKETS

NASA NO.: 14.127

VEHICLE: Nike Apache

DATE/SITE: November 1963/Wallops Island

HEADQUARTERS

CONTACT: A. G. Opp
Alternate: J. Holtz

EXPERIMENTER: R. G. Stone, GSFC

PARAMETER: Radio astronomical parameters

EXPERIMENT: Measurement and comparison of radiating and non-radiating sensors for support of future space radio astronomy missions. Impedance characteristics will be related to ionospheric electron and ion densities.

TECHNIQUE: Impedance measurements on a short dipole. Ion and electron density measurements utilizing swept frequency technique

INSTRUMENT: Two short dipoles, parallel plates

DISCIPLINE: Astronomy (prime)
Ionospheres & Radio Physics

GEOPROBES AND SOUNDING ROCKETS

NASA NO.: 14.128 - 14.131

VEHICLE: Nike Apache

DATE/SITE: November 1963/India

HEADQUARTERS

CONTACT: M. Dubin
Alternate: J. Holtz

EXPERIMENTER: Vikram Sarabhai
Chairman
Indian Natl. Committee for Space Research
Physical Research Lab., India

PARAMETER: Wind velocity, shears, and diffusion coefficient.

EXPERIMENT: Investigate the tidal and dynamo motions and current systems between 80 and 200 km altitude.

TECHNIQUE: Release of fluorescent (alkali) vapors in the atmosphere at twilight.

INSTRUMENT: Photographic camera net

DISCIPLINE: Planetary Atmospheres (prime)
Ionospheres & Radio Physics

GEOPROBES AND SOUNDING ROCKETS

NASA NO.: 14.143 - 14.149

VEHICLE: Nike Apache

DATE/SITE: April, July, October 1964/Wallops and India

TRAJECTORY: 180 km

HEADQUARTERS

CONTACT: A. G. Opp
Alternate: J. R. Holtz

EXPERIMENTER: S. A. Bowhill, Univ. of Illinois
L. G. Smith, Geophysics Corp. of America

CONTRACTOR/
AGENCY: Univ. of Illinois, College of Engineering
Univ. of Illinois, Coordinated Science Lab.
Geophysics Corp. of America

PARAMETER: Density as function of height, electron
density as function of height, ionizing
flux; positive and negative ion ratios.

EXPERIMENT: A joint coordinated sounding rocket
program to study the ionosphere between
the heights of 70 - 160 km over broad
geographic areas.

TECHNIQUE: Radio propagation, conductivity measure-
ments, Faraday rotation, rf impedance
probe, ion traps

INSTRUMENT: Lyman and 1450 \AA ion chambers, Langmuir
probe, differential absorption, measuring
receiving rf ion mass spectrometer, rf
resonance probe, 44 - 60 \AA photon counter

DISCIPLINE: Ionospheres & Radio Physics

GEOPROBES AND SOUNDING ROCKETS

NASA NO.: 14.150 - 14.154

VEHICLE: Nike Apache

DATE/SITE: 1Q64/Wallops Island and Ft. Churchill

TRAJECTORY: 200 km

HEADQUARTERS

CONTACT: J. W. Freeman
Alternate: J. R. Holtz

EXPERIMENTER: Brian J. O'Brien

CONTRACTOR/
AGENCY: Rice University, Houston, Texas

PARAMETER: Auroral and airglow precipitating
electrons and protons, light, and magnetic
fields

EXPERIMENT: Obtain definitive information about the
causes of the aurorae and the airglow by
examining the corpuscular and light
radiations simultaneously.

TECHNIQUE: A full complement of 10 detectors will
be utilized consisting of: 1) 2 auroral-
airglow photometers; 2) 2 thin window
geiger counters; 3) 3 low energy particle
detectors (either cesium iodide scintil-
lators or CdS crystals); 4) a three axis
magnetometer.

DISCIPLINE: Particles & Fields (prime)
Planetary Atmospheres

GEOPROBES AND SOUNDING ROCKETS

NASA NO.: 14.155 - 14.160

VEHICLE: Nike Apache

DATE/SITE: January-May 1964/Wallops Island

TRAJECTORY: 200 km

HEADQUARTERS

CONTACT: J. W. Freeman
Alternate: J. R. Holtz

EXPERIMENTER: N. Davis, GSFC

PARAMETER: Magnetic fields

EXPERIMENT: Measure magnetic fields in the ionosphere
and auroral electrojet

TECHNIQUE AND
INSTRUMENT: Total field measurements employing dual
or four gas cell Rb vapor magnetometers.

DISCIPLINE: Particles & Fields

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Magnetodynamics

TITLE: A theoretical study of the ring current and geomagnetic field phenomena

PRINCIPAL INVESTIGATOR: Syun-ichi Akasofu
Sydney Chapman

ORGANIZATION: Geophysical Institute
College, Alaska

CONTRACT NUMBER: NsG 201 (Suppl. 2)

TIME PERIOD: 1 Jan. 1963 - 31 Dec. 1963

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$68,780

TECHNICAL MONITOR: J. W. Freeman

ALTERNATE CONTACT: J. E. Naugle

DESCRIPTION: This is an interpretive and theoretical study of ring current effects. Surface magnetic measurements, satellite particle and magnetic measurements, and calculated ring current fields are to be correlated.

DISCIPLINE: Particles & Fields

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Energetic particles

TITLE: Experimental studies of auroral phenomena, including electromagnetic and particulate fluxes, by means of balloon- and rocket-borne experiments

PRINCIPAL INVESTIGATOR: W. B. Mucray and M. Almasi

ORGANIZATION: University of Alaska
College, Alaska

CONTRACT NUMBER: NsG 406

TIME PERIOD: 1 May 1963 - 30 April 1964

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$59,921

TECHNICAL MONITOR: J. W. Freeman
J. R. Holtz

DESCRIPTION: This grant is for the design construction and flight of an auroral experiment to measure auroral light, particle flux, UV and gamma flux. The experiment will be conducted first by balloon flight in Alaska and then with four (4) Nike Cajun or Nike Apache rocket flights launched from Ft. Churchill.

DISCIPLINE: Particles & Fields

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Ground studies of space flight
environmental effects on organisms

TITLE: Experimental studies on physiological
adaptation to environmental extremes

PRINCIPAL INVESTIGATOR: Peter Morrison

ORGANIZATION: University of Alaska
College, Alaska

CONTRACT NUMBER: NsG 459

TIME PERIOD: 1 June 1963 - 31 May 1964

FUNDED BY: Bioscience Programs

AMOUNT: \$50,000

TECHNICAL MONITOR: D. W. Jenkins

DESCRIPTION: To study effects of environmental
extremes on mammals, particularly
cold temperatures,

DISCIPLINE: Bioscience

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Meteorites and Tektites

TITLE: A program to improve the sample
distribution program of the
Nininger Meteorite Collection

PRINCIPAL INVESTIGATOR: Carleton B. Moore

ORGANIZATION: Arizona State University
Tempe, Arizona

CONTRACT NUMBER: NSG 399

TIME PERIOD: 1 March 1963 - 28 Feb. 1965

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$28,978

TECHNICAL MONITOR: R. P. Bryson

DESCRIPTION: A program to improve the sample
distribution program of the
Nininger Meteorite Collection.

DISCIPLINE: Planetology

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Ground based Astronomy

TITLE: Planetary information center

PRINCIPAL INVESTIGATOR: J. S. Hall

ORGANIZATION: Lowell Observatory
Flagstaff, Arizona

CONTRACT NUMBER: NsG 451

TIME PERIOD: 1 July 1963 - 30 June 1966

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$174,000

TECHNICAL MONITOR: R. C. Moore

DESCRIPTION: Establishment and operation of a
western hemisphere planetary
information center.

DISCIPLINE: Planetology

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Planetary Astronomy

TITLE: Lunar & Planetary 60-inch telescope

PRINCIPAL INVESTIGATOR: G. P. Kuiper

ORGANIZATION: University of Arizona
Tucson, Arizona

CONTRACT NUMBER: NASr 82

TIME PERIOD: 21 Aug. 1962 - 20 Aug. 1964

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$375,000

TECHNICAL MONITOR: R. C. Moore

DESCRIPTION: Construction of a 60-inch lunar &
planetary telescope

DISCIPLINES: Planetology (prime)
Astronomy
Planetary Atmospheres

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Balloon-based Astronomy

TITLE: Balloon-borne Polarimetry Research

PRINCIPAL INVESTIGATOR: A. M. J. Gehrels

ORGANIZATION: University of Arizona
Tucson, Arizona

CONTRACT NUMBER: NASr 138

TIME PERIOD: 1 Nov. 1962 - 31 Oct. 1964

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$65,286

TECHNICAL MONITOR: R. C. Moore

DESCRIPTION: Development and flight testing of
Mariner B Photopolarimeter.

DISCIPLINE: Planetology

SUPPORTING RESEARCH

AREA OF INVESTIGATION: X-rays

TITLE: Study of physics of ultra-soft
X-rays

PRINCIPAL INVESTIGATOR: R. Wyckoff

ORGANIZATION: University of Arizona
Tucson, Arizona

CONTRACT NUMBER: NsG 120 (Suppls. 1 & 2)

TIME PERIOD: 1 - 1 May 1962 - 30 April 1965
2 - 1 May 1963 - 30 April 1966

AMOUNT: 1 - \$100,000
2 - \$50,025

TECHNICAL MONITOR: H. J. Smith

DESCRIPTION: Investigation of the generation and
detection of ultra-long wave length
X-rays and quantitative studies of
their interactions with matter.

DISCIPLINE: Solar Physics

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Astronomy for lunar and planetary investigations

TITLE: Selenodetic and physical studies of the lunar surface

PRINCIPAL INVESTIGATOR: G. P. Kuiper

ORGANIZATION: University of Arizona
Tucson, Arizona

CONTRACT NUMBER: NsG 161 (Suppl. 2)

TIME PERIOD: 1 June 1963 - 30 June 1966

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$402,000

TECHNICAL MONITOR: R. C. Moore

DESCRIPTION: This grant supports broad telescopic studies of the moon and the planets. It includes continual photography, visual observations, selenodesy, standard coordinates, crater diameters, atlases, and polarization studies of the moon.

DISCIPLINE: Planetology

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Planetary Atmospheres

TITLE: Development of chemisorption
detectors

PRINCIPAL INVESTIGATOR: S. A. Hoenig

ORGANIZATION: University of Arizona
Tucson, Arizona

CONTRACT NUMBER: NsG 458

TIME PERIOD: 1 June 1963 - 31 May 1964

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$41,138

TECHNICAL MONITOR: D. P. Easter

ALTERNATE CONTACT: E. A. Gaugler

DESCRIPTION: Development of chemisorption
detectors.

DISCIPLINE: ✓ Planetary Atmospheres (prime)
✓ Planetology

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Polarimetry

TITLE: Laboratory experiments & reductions
of photometry & polarimetry

PRINCIPAL INVESTIGATOR: A. M. J. Gehrels

ORGANIZATION: University of Arizona
Tucson, Arizona

CONTRACT NUMBER: NsG 493

TIME PERIOD: 15 June 1963 - 15 June 1964

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$9,168

TECHNICAL MONITOR: N. G. Roman

DESCRIPTION: Analysis and reduction of photometric
and polarimetric observations of
planets and other objects in the
solar system.

DISCIPLINE: Astronomy

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Geophysics - related to lunar work

TITLE: Research on meteorites and lunar problems

PRINCIPAL INVESTIGATOR: H. Brown

ORGANIZATION: Calif. Inst. of Tech.
Pasadena, California

CONTRACT NUMBER: NsG 56-60 (Suppl. 4)

TIME PERIOD: 1 Dec. 1962 - 31 Nov. 1963

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$173,700

TECHNICAL MONITOR: R. J. Allenby

DESCRIPTION: The technical objective of this grant is to improve our knowledge of the geology, geochemistry, and geophysics of the moon. This involves the following research areas: (1) Theoretical analysis of the behavior of volatile lunar substances. (2) Photoelectric investigations of lunar color variations. (3) Geochemical study of meteorite thin sections. (4) X-ray fluorescence studies. (5) Shadow variation studies of lunar photographs. (6) Development of an Earth-based lunar infrared telescope. (7) Compilation and translation of lunar literature.

DISCIPLINE: Planetology

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Extraterrestrial Sample Collection & Analysis

TITLE: An investigation of the biochemistry of meteorites, with emphasis on the hydrocarbon and sulfur constituents

PRINCIPAL INVESTIGATOR: Isaac R. Kaplan

ORGANIZATION: Calif. Inst. of Tech.
Pasadena, California

CONTRACT NUMBER: NsG 347

TIME PERIOD: 1 Jan. 1963 - 31 Dec. 1963

FUNDED BY: Bioscience Programs

AMOUNT: \$7,145

TECHNICAL MONITOR: F. Quimby

DESCRIPTION: To identify organic materials in meteorites, specifically the light and heavy hydrocarbons; and also hydrogen, carbon, and sulfur isotopes.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Ground-based Astronomy

TITLE: A program of research in selected fields of physics and astronomy

PRINCIPAL INVESTIGATOR: R. Leighton

ORGANIZATION: Calif. Inst. of Tech.
Pasadena, California

CONTRACT NUMBER: NsG 426

TIME PERIOD: 1 April 1963 - 31 March 1966

FUNDED BY & AMOUNT: \$440,000 - Lunar & Planetary Programs
\$180,000 - Geophysics & Astronomy Programs
\$260,000 - Grants & Research Contracts

TECHNICAL MONITOR: E. A. Gaugler (L&P)
U. Liddel (L&P)
N. Roman (G&A)
A. Schardt (G&A)
J. Holloway (G&RC)

DESCRIPTION: A program of research in selected fields of physics and astronomy; interplanetary magnetic fields, theoretical astrophysics, planetary spectroscopy, and I.R. astronomy. The Geophysics & Astronomy (Physics) contribution to this grant provides support for the cosmic ray studies of R. Vogt and H. V. Neher.

DISCIPLINE: Particles & Fields (prime)
Planetology

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Nutrition

TITLE: Individualized chemically-defined diets in life support systems during space flight

PRINCIPAL INVESTIGATOR: Milton Winitz

ORGANIZATION: City of Hope Medical Center
Duarte, California

CONTRACT NUMBER: NsG 285 (Suppl. 1)

TIME PERIOD: 1 Dec. 1962 - 30 Nov. 1963

FUNDED BY: Bioscience Programs

AMOUNT: \$352,642

TECHNICAL MONITOR: G. J. Jacobs

DESCRIPTION: To conduct an experimental investigation of the basic dietary requirements of man with emphasis on water-soluble, chemically-defined diets.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Physiology & Space Metabolic Requirements

TITLE: A clinical evaluation of chemically-defined diets suitable for space flight missions

PRINCIPAL INVESTIGATOR: Milton Winitz

ORGANIZATION: Medical Science Research Foundation
San Francisco, California

CONTRACT NUMBER: NsG 510

TIME PERIOD: 1 July 1963 - 30 June 1964

FUNDED BY: Bioscience Programs

AMOUNT: \$412,452

TECHNICAL MONITOR: G. Jacobs

DESCRIPTION: To conduct an experimental investigation of the basic dietary requirements of man with emphasis on water-soluble, chemically-defined diets.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH

AREA OF INVESTIGATION: General biological studies and supporting activities

TITLE: A symposium on cytogenetics of cells in culture, including radiation studies

PRINCIPAL INVESTIGATOR: C. M. Pomerat

ORGANIZATION: Pasadena Foundation for Medical Research
Pasadena, California

CONTRACT NUMBER: NsG 457

TIME PERIOD: 1 May 1963 - 31 Oct. 1963

FUNDED BY: Bioscience Programs

AMOUNT: \$13,500

TECHNICAL MONITOR: G. J. Jacobs

DESCRIPTION: Topics to be discussed include DNA synthesis, effects of long-terms, low-level radiation and effects of heavy particles on chromosomes.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Ground-based Astronomy

TITLE: Solar constants

PRINCIPAL INVESTIGATOR: G. F. Schilling

ORGANIZATION: RAND Corporation
Santa Monica, California

CONTRACT NUMBER: NASr 21(04) (Amd. 1 & 2)

TIME PERIOD: 1 Nov. 1962 - 31 Oct. 1963
plus no cost extension to 31 Jan. 1964

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$86,110

TECHNICAL MONITOR: R. C. Moore

DESCRIPTION: Research leading to the preparation
of tables of constants and parameters
of the solar system.

DISCIPLINE: Planetology

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Magnetodynamics

TITLE: Charged particles and fields in space

PRINCIPAL INVESTIGATOR: E. H. Vestine

ORGANIZATION: RAND Corporation
Santa Monica, California

CONTRACT NUMBER: NASr 21(05) (Amd. 2)

TIME PERIOD: July 1963 - June 1965

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$200,000

TECHNICAL MONITOR: A. Schardt

DESCRIPTION: 1. Conduct theoretical studies of the charged particle populations of the trapped radiation zones.
2. Correlate the charged particle studies with related effects such as auroral effects and magnetic field effects caused by the charged particles.

DISCIPLINE: Particles & Fields

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Micrometeorite simulation

TITLE: Investigation of high speed impact phenomena

PRINCIPAL INVESTIGATOR: D. B. Langmuir

ORGANIZATION: Space Technology Laboratory
Los Angeles, California

CONTRACT NUMBER: NASw 561

TIME PERIOD: 1 Nov. 1962 - 30 Nov. 1963

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$92,340

TECHNICAL MONITOR: O. Berg, GSFC

ALTERNATE CONTACT: M. Dubin

DESCRIPTION: Investigation of the physics of hypervelocity impacts and meteor simulation using the 2 Mev acceleration for the study of crater formation, light emission, charged particle creation, and temperature changes in various materials as a function of particle velocity, material, and mass.

DISCIPLINE: Planetary Atmospheres

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Particles and Fields

TITLE: Theoretical study

PRINCIPAL INVESTIGATOR: F. L. Scarf

ORGANIZATION: Space Technology Labs
Redondo Beach, California

CONTRACT NUMBER: NASw 698

TIME PERIOD: 14 June 1963 - 14 July 1964

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$54,522

TECHNICAL MONITOR: E. A. Gaugler

DESCRIPTION: Conduct a theoretical study of the
coupling between the solar wind and
the exosphere

DISCIPLINE: Particles & Fields (prime)
Planetology

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Geochemistry - research in methods and instrumentation

TITLE: Program on evaluation of infrared spectrophotometry for compositional analysis of lunar and planetary soils

PRINCIPAL INVESTIGATOR: R. J. P. Lyon

ORGANIZATION: Stanford Research Institute
Menlo Park, California

CONTRACT NUMBER: NASr 49(04) (Amd. 2)

TIME PERIOD: 30 June 1963 - 31 Jan. 1964

AMOUNT: \$47,025

TECHNICAL MONITOR: R. J. Allenby

DESCRIPTION: This grant is to investigate infrared absorption and reflection peaks in order to derive accurate data for rocks and minerals expected to be found on lunar and planetary surfaces. Infrared absorption analysis is in many cases to be preferred over x-ray diffraction or differential thermal analysis because it permits simple quantitative determination of many constituents, determination of glass composition, and the definition of the character of "water" contained in a hydrated mineral. This work, done under optimum laboratory conditions, may serve as the basis for instrumentation on planetary surface vehicles or orbiting spacecraft.

DISCIPLINE: Planetology

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Collision theory

TITLE: Studies in atomic impact theory

PRINCIPAL INVESTIGATOR: Felix T. Smith

ORGANIZATION: Stanford Research Institute
Menlo Park, California

CONTRACT NUMBER: NASr 49(07) (Amd. 1)

TIME PERIOD: 15 April 1962 - 14 April 1963
no cost extension to 14 Jan. 1964

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$49,140

TECHNICAL MONITOR: J. Gilbert, GSFC

ALTERNATE CONTACT: R. F. Fellows

DESCRIPTION: Conduct theoretical research on
low energy electronic, ionic and
atomic impact phenomena.

DISCIPLINE: Planetary Atmospheres

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Biophysics and molecular biology

TITLE: Studies on the Hill reaction
activity of soluble chloroplast
extracts

PRINCIPAL INVESTIGATOR: Bruce Graham

ORGANIZATION: Stanford Research Institute
Menlo Park, California

CONTRACT NUMBER: NASr 49 (11)

TIME PERIOD: 1 March 1963 - 28 Feb. 1964

FUNDED BY: Bioscience Programs

AMOUNT: \$27,850

TECHNICAL MONITOR: G. J. Jacobs

DESCRIPTION: Study the characterization of photo-
chemically active extract to
chloroplasts, define the components
required in the photo-active system,
and learn the role of each of the
energy transfer processes.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Evolutionary and theoretical biology

TITLE: Magnetic properties of some macromolecules of biological interest

PRINCIPAL INVESTIGATOR: R. B. Vaile

ORGANIZATION: Stanford Research Institute
Menlo Park, California

CONTRACT NUMBER: NASr 49 (16)

TIME PERIOD: 1 Aug. 1963 - 31 July 1964

FUNDED BY: Bioscience Programs

AMOUNT: \$52,674

TECHNICAL MONITOR: G. J. Jacobs

DESCRIPTION: Investigate the magnetic susceptibility of selected pure organic compounds and correlate measurements made with structure, physical and chemical properties of the compounds investigated.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Ionospheres & Radio Physics

TITLE: Conduct research to obtain information about the electron content in the ionosphere and its variation

PRINCIPAL INVESTIGATOR: O. K. Garriott

ORGANIZATION: Stanford University
Stanford, California

CONTRACT NUMBER: NASr 136

TIME PERIOD: 1 Nov. 1962 - 31 Oct. 1964

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$186,500

TECHNICAL MONITOR: A. G. Opp

DESCRIPTION: By observing the Faraday rotation, differential doppler shift and group delay, ionospheric and exospheric electron contents are obtained. Since the OGO-A satellite will vary considerably in altitude only some portions of its orbit at a time when the spacecraft is nearly geostationary, a good measure is obtained of the variation of electron density with height. Phase-locked receivers are necessary in order to obtain data at the extreme ranges of the satellite.

DISCIPLINE: Ionospheres & Radio Physics

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Ionospheric Physics

TITLE: Ionospheric research utilizing
satellite transmissions

PRINCIPAL INVESTIGATOR: O. K. Garriott

ORGANIZATION: Stanford University
Stanford, California

CONTRACT NUMBER: NsG 30 (Suppl. 3)

TIME PERIOD: 1 Jan 1963 - 31 Dec. 1963

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$94,186

TECHNICAL MONITOR: A. G. Opp

DESCRIPTION: Continuation of present program of
data collection and analysis in
support of the BE-A Ionosphere
Beacon Satellite and for other
satellites with suitable trans-
missions. Faraday rotation and
differential doppler measurements
are used for electron content deter-
minations and observations on
irregularities.

DISCIPLINE: Ionospheres & Radio Physics

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Instrumentation for detection of extraterrestrial life and life-related compounds

TITLE: Cytochemical studies of planetary microorganisms

PRINCIPAL INVESTIGATOR: J. Lederberg

ORGANIZATION: Stanford University
Stanford, California

CONTRACT NUMBER: NsG 81 (Suppls. 1 & 2)

TIME PERIOD: April 1961 - 31 March 1964
April 1963 - 31 March 1964

FUNDED BY: Bioscience Programs

AMOUNT: \$380,640
\$132,000

TECHNICAL MONITOR: F. H. Quimby

DESCRIPTION: To conduct research, design and test a device ("multivator") comprising a variety of reagents, for detection of the presence of microbes. Methods for the detection of microbial enzymes, growth and metabolism for use in multivator chambers; methods for concentration of microbes; and for their characterization for DNA and protein by semi-microphotometry will be studied. Also, to design a scheme for the examination of single particles or microorganisms by means of optical microscopy and spectrophotometry of the particle or particles in the microscopic field. General studies of methods of detecting and characterizing Martian biota.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Ionospheres & Radio Physics

TITLE: Conduct investigation of experimental techniques for measurement of very low frequency electromagnetic phenomena in the ionosphere

PRINCIPAL INVESTIGATOR: R. A. Helliwell

ORGANIZATION: Stanford University
Stanford, California

CONTRACT NUMBER: NsG 174 (Suppl 1)

TIME PERIOD: 1 March 1963 - 28 Feb. 1966

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$93,390

TECHNICAL MONITOR: A. G. Opp

DESCRIPTION: . VLF measurements give information on the interactions between incoming low energy particles and electromagnetic energy. Whistler mode signals propagate nearly along field lines, and give information on electron densities in the exosphere and also electron contents between the ground and satellites. The theory of making these measurements by antennas which can be calibrated to give absolute field strengths needs further development as does the theory of the generation and amplification of VLF noise by particle-wave interaction.

DISCIPLINE: Ionospheres & Radio Physics

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Evolutionary & theoretical biology

TITLE: Molecular evolution

PRINCIPAL INVESTIGATOR: S. Blois and H. Pattee

ORGANIZATION: Stanford University
Stanford, California

CONTRACT NUMBER: NsG 218

TIME PERIOD: 1 Dec. 1961 - 30 Nov. 1964

FUNDED BY: Bioscience Programs

AMOUNT: \$86,800

TECHNICAL MONITOR: F. H. Quimby

DESCRIPTION: To produce and study "protobiological systems" or precellular chemical systems incapable of reproduction but which may carry out complex metabolism. A search will be made for catalysts in Miller-type experiments by adding materials to such experiments which will make the appearance and action of low molecular weight organic or metallo-organic catalysts a possibility.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Ionospheres & Radio Physics

TITLE: Radio propagation techniques for
the study of planetary ionospheres &
interplanetary medium

PRINCIPAL INVESTIGATOR: O. K. Garriott

ORGANIZATION: Stanford University
Stanford, California

CONTRACT NUMBER: NsG 329

TIME PERIOD: 1 Oct. 1962 - 30 Sept. 1963

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$81,000

TECHNICAL MONITOR: D. P. Easter

DESCRIPTION: Includes development, through
prototype, of spacecraft instrument
required to receive and process
signals; one at 50 Mc and one at
higher harmonic of 50 Mc.

DISCIPLINE: Ionospheres & Radio Physics (prime)
Planetology
Planetary Atmospheres

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Radar astronomy for lunar investigations

TITLE: Program of lunar and planetary research with radio and radar astronomy techniques

PRINCIPAL INVESTIGATOR: V. R. Eshelman

ORGANIZATION: Stanford University
San Francisco, California

CONTRACT NUMBER: NsG 377

TIME PERIOD: 1 Jan. 1963 - 31 Dec. 1965

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$246,620

TECHNICAL MONITOR: D. P. Easter

DESCRIPTION: Research program includes: (1) Radio transmissions from present ground facilities, with reception in space probes, for studies of lunar and planetary surfaces. (2) Radar studies (with Earth transmission and reception) of the moon and planets. (3) Theoretical studies in the above areas.

DISCIPLINE: Planetology (prime)
Ionospheres & Radio Physics (prime)
Planetary Atmospheres

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Evolution & Theoretical Biology

TITLE: Studies on reflection spectra, meteorite analysis, and chemical evolution

PRINCIPAL INVESTIGATOR: Melvin Calvin and H. Weaver

ORGANIZATION: University of California
Berkeley, California

CONTRACT NUMBER: NsG 101 (Suppl. 1)

TIME PERIOD: Aug. 1962 - Aug. 1965

FUNDED BY: Bioscience Programs

AMOUNT: \$252,500

TECHNICAL MONITOR: F. H. Quimby

DESCRIPTION: Conduct work on the nature and physics of reflection spectra as a basis for studying extraterrestrial life. To determine the chemical structure and amount of carbon compounds in meteorites. To conduct paleobiochemical studies on Pre-Cambrian Rocks with respect to the origin of life and the fate of biological residues and to study chemical evolution utilizing UV energy at 2500Å and identify the resultant compounds by means of paper chromatography and mass spectrometry.

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Effects of simulated extraterrestrial environments on earth organisms

TITLE: Biochemical activities of terrestrial microorganisms in simulated planetary environments

PRINCEPAL INVESTIGATOR: S. Silver

ORGANIZATION: University of California
Berkeley, California

CONTRACT NUMBER: NsG 126

TIME PERIOD: Feb. 1961 - Jan. 1964

FUNDED BY: Bioscience Programs

AMOUNT: \$198,000

TECHNICAL MONITOR: D. W. Jenkins

DESCRIPTION: Study the growth and biochemical activities of terrestrial microorganisms under conditions of primitive and contemporary environments of the terrestrial planets.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Energetic Particles

TITLE: Theoretical and experimental investigations of high energy solar flare radiation and of trapped radiation, including balloon-borne and/or sounding rocket tests of prototype detectors

PRINCIPAL INVESTIGATOR: Kinsey Anderson

ORGANIZATION: University of California
Berkeley, California

CONTRACT NUMBER: NSG 387

TIME PERIOD: 1 Feb. 1963 - 31 Jan. 1966

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$130,000

TECHNICAL MONITOR: J. W. Freeman

DESCRIPTION: This grant provides support for the investigations of solar flare energetic particles and trapped radiation arising from the past balloon investigations of Dr. Anderson. It also continues detector development which has led to acceptance of Univ. of California experiments for the IMP and EGO satellites.

DISCIPLINE: Particles & Fields

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Inelastic neutron scattering

TITLE: Theoretical and experimental evaluation of inelastic neutron scattering and other neutron induced reactions for remote surface analysis

PRINCIPAL INVESTIGATOR: H. Mark

ORGANIZATION: University of California
Livermore, California

CONTRACT NUMBER: NsG 452

TIME PERIOD: 1 April 1963 - 31 March 1965

FUNDED BY: Lunar & Planetary Programs

TECHNICAL MONITOR: R. J. Allenby

DESCRIPTION: A flight instrument will be built capable of elemental analysis of the lunar surface utilizing inelastic neutron scattering.

DISCIPLINE: Planetology

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Evolutionary & theoretical biology

TITLE: Chemistry of living systems

PRINCIPAL INVESTIGATOR: Hardin Jones

ORGANIZATION: University of California
Berkeley, California

CONTRACT NUMBER: NsG 479

TIME PERIOD: 1 June 1963 - 31 May 1964

FUNDED BY: Bioscience Programs

AMOUNT: \$403,548

TECHNICAL MONITOR: F. H. Quimby

DESCRIPTION: This research is oriented toward the increased understanding of biology through the study of living chemical structures. It involves the organization and differentiation of cells and tissues, time relationships in chemical biology, selected problems in comparative biochemistry, storage of biological information (chemistry of memory), etc.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Geophysics - basic research

TITLE: Theoretical investigation of the constitution of the moon and planets

PRINCIPAL INVESTIGATOR: G. J. F. MacDonald

ORGANIZATION: University of California
Los Angeles, California

CONTRACT NUMBER: NsG 216

TIME PERIOD: 1 Jan. 1962 - 31 Dec. 1963

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$113,964

TECHNICAL MONITOR: R. J. Allenby

DESCRIPTION: This project is for theoretical calculations on the internal structure of the planets and the structure of their atmospheres. It is proposed to investigate the effect of convected heat on the thermal balance of the planet. In addition, a study will be made of the mass distribution within the planet compatible with astronomical observations and with thermal calculation.

DISCIPLINE: Planetology

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Particles & Fields

TITLE: Low energy proton detector system

PRINCIPAL INVESTIGATOR: Thomas A. Farley

ORGANIZATION: University of California
 Los Angeles, California

CONTRACT NUMBER: NsG 249 (Suppl. 1)

TIME PERIOD: 1 July 1963 - 30 June 1966

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$199,880

TECHNICAL MONITOR: U. Liddel

DESCRIPTION: The objective is to design, develop,
 and construct a single flight
 prototype of a low energy proton
 detector. This instrument, when
 developed, will measure the spectral
 intensity of protons in the energy
 range between 0.2 and 5.0 Mev. It
 should provide ample discrimination
 against electrons of all but the
 greatest intensities observed in the
 outer zone. This instrument is
 being developed for the Ranger
 program.

DISCIPLINE: Particles & Fields

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Meteorite and tektite studies

TITLE: Investigate the isotopic chemistry of meteorites

PRINCIPAL INVESTIGATOR: G. Wetherill

ORGANIZATION: University of California
Los Angeles, California

CONTRACT NUMBER: NsG 313

TIME PERIOD: 1 Sept. 1962 - 31 Aug. 1964

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$72,430

TECHNICAL MONITOR: R. J. Allenby

DESCRIPTION: Recent results indicate that large isotopic variations may exist between different meteorites. These variations can arise only if the meteorite came from different parent bodies or if the fragments have had greatly different histories since the breakup of the parent body. Many of our assumptions about meteorites will be changed if these isotopic variations are confirmed. By means of spectrometric and radiochemical techniques, this project will investigate these reported isotopic variations.

DISCIPLINE: Planetology

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Geochemistry - basic research

TITLE: Study solid inert gases at high pressures

PRINCIPAL INVESTIGATOR: G. C. Kennedy

ORGANIZATION: University of California
Los Angeles, California

CONTRACT NUMBER: NsG 314

TIME PERIOD: 1 Oct. 1962 - 30 Sept. 1964

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$85,000

TECHNICAL MONITOR: R. J. Allenby

DESCRIPTION: Study the solid phases of noble gases and hydrogen, methane, ammonia, and CO₂ at high pressures. Most materials, including inert gases, are drastically affected by very high pressures. Possibly we will never know the real nature of a planetary interior, (even if the asteroid belt did form from a planet, we must assume that retrograde metamorphism has altered the fragments); but, on the other hand, we can subject likely materials to pressures known to exist in a planetary interior and determine phase equilibria for various temperatures and pressures. These results will enable us to construct a much more likely model of planetary interiors.

DISCIPLINE: Planetology

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Geophysics - related to lunar work

TITLE: Magnetic measurements of lunar rocks

PRINCIPAL INVESTIGATOR: V. Vacquier and J. C. Belshe

ORGANIZATION: University of California
San Diego, California

CONTRACT NUMBER: NsG 303

TIME PERIOD: 1 Oct. 1962 - 30 June 1964

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$27,200

TECHNICAL MONITOR: A. E. Gaugler

DESCRIPTION: One of the primary properties of the moon is its magnetic field. To properly understand this field, we must know the magnetic characteristics of the lunar rocks. The grant is for the purpose of developing reliable and ultra-sensitive magnetometers to accomplish this objective.

DISCIPLINE: Planetology

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Meteorite and tektite studies

TITLE: Composition and structure of meteorites and the lunar surface

PRINCIPAL INVESTIGATOR: G. O. S. Arrhenius

ORGANIZATION: University of California
San Diego, California

CONTRACT NUMBER: NsG 317

TIME PERIOD: 1 July 1962 - 30 Sept. 1964

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$83,018

TECHNICAL MONITOR: R. P. Bryson

DESCRIPTION: This is a grant for a detailed study of the petrography and composition of meteorites, and of the effects of shock waves on rock. Knowledge of the petrography of meteorites is extremely important in helping us work out the history of the meteorites. For example, crystal size and shape is indicative of the heat and pressure of the forming body. Recrystallization indicates remelting at some time in the meteorite's life. Knowledge of chemical composition will help us determine not only the original chemical composition of the solar system, but also the amount of differentiation that has taken place since that time. Shock waves probably have lead to the formation of some minerals found in meteorites; if such minerals can be recognized they will assist in the interpretation of the history of the particular meteorite.

DISCIPLINE: Planetology

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Energetic particles

TITLE: Study of geomagnetically trapped particles

PRINCIPAL INVESTIGATOR: Carl E. McIlwain

ORGANIZATION: University of California
San Diego, California

CONTRACT NUMBER: NASr 116

TIME PERIOD: 27 July 1962 - 30 June 1963
plus no cost extensions to
30 Sept. 1963 to 31 Dec. 1963

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$277,997

TECHNICAL MONITOR: J. W. Freeman

ALTERNATE CONTACT: Daniel M. Brown, GSFC

DESCRIPTION: This research is a program of experimental and theoretical investigation of trapped radiation.

DISCIPLINE: Particles & Fields

SUPPORTING RESEARCH

AREA OF INVESTIGATION: X-ray and gamma-ray astronomy

TITLE: Experimental research on X- and gamma-radiation at high altitudes, including design and use of balloon-borne instrumentation

PRINCIPAL INVESTIGATOR: L. E. Peterson

ORGANIZATION: University of California
La Jolla, California

CONTRACT NUMBER: NsG 318

TIME PERIOD: 15 Sept. 1962 - 14 Sept. 1963

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$85,000

TECHNICAL MONITOR: N. G. Roman and E. J. Ott

DESCRIPTION: Continue work begun with a satellite-borne instrument to measure X- and γ -ray radiation. To develop balloon-borne instrumentation to measure X- and γ -ray radiation.

DISCIPLINE: Astronomy

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Meteorite and tektite studies

TITLE: Study trace elements in meteorites

PRINCIPAL INVESTIGATOR: G. G. Goles

ORGANIZATION: University of California
San Diego, California

CONTRACT NUMBER: NsG 319

TIME PERIOD: 15 Sept. 1962 - 14 Sept. 1964

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$55,158

TECHNICAL MONITOR: R. J. Allenby

DESCRIPTION: This is a project to determine the relative abundances of eleven trace elements in various meteorites. Studies of the abundances of these elements in meteorites, especially chondrites, have proven most useful in outlining the "cosmic abundance curve." However, fractionation processes have modified these abundances, and the nature and extent of the fractionation must be investigated. The results of this work will lead to a better understanding of the original chemical composition of the solar system and a better model of the chemical and physical history of the meteorites.

DISCIPLINE: Planetology

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Meteorite and tektite studies

TITLE: The interaction of meteorites and cosmic rays

PRINCIPAL INVESTIGATOR: J. R. Arnold

ORGANIZATION: University of California
San Diego, California

CONTRACT NUMBER: NsG 321

TIME PERIOD: 15 Sept. 1962 - 14 Sept. 1965

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$102,331

TECHNICAL MONITOR: R. J. Allenby

DESCRIPTION: The technical objectives of this grant are to continue studies on the interaction of meteorites and cosmic rays, and to consider the origin and history of meteorites. Work in this field has progressed to the point where it is felt that cosmic ray intensity has been relatively consistent in past time. In this case, the study of the cosmic ray history of the meteorites will determine the exposure times, the amount of shielding, and perhaps, the relative position of a meteorite in its parent body. Work will also be conducted on the geochemistry of the early solar nebula, including condensation of liquid and solid materials from it.

DISCIPLINE: Planetology

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Meteorite and tektite studies

TITLE: Determine cosmic abundance of elements

PRINCIPAL INVESTIGATOR: H. E. Suess

ORGANIZATION: University of California
San Diego, California

CONTRACT NUMBER: NsG 322

TIME PERIOD: 15 Sept. 1962 - 14 Sept. 1964

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$66,242

TECHNICAL MONITOR: R. J. Allenby

DESCRIPTION: The basic scientific objective of this project is to derive accurate data for the chemical composition of the primeval medium from which the terrestrial planets formed. Work at present involves studies on the degree of oxidation of meteorites, the primordial rare gas content of meteorites, and the study of how much mass separation in the gas phase had taken place at the time of formation of the solar system. The work involves measurements utilizing the electron microprobe and X-ray fluorescence methods.

DISCIPLINE: Planetology

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Meteorite and tektite studies

TITLE: Study the inert gases of meteorites

PRINCIPAL INVESTIGATOR: H. C. Urey

ORGANIZATION: University of California
San Diego, California

CONTRACT NUMBER: NsG 323

TIME PERIOD: 15 Sept. 1962 - 14 Sept. 1964

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$73,054

TECHNICAL MONITOR: R. J. Allenby

DESCRIPTION: This grant is to study the relative isotopic abundances of various elements in meteorites, extract and study the inert gases in meteorites, and determine meteorite ages. Preliminary measurements on a few meteorites have shown that isotopic variations exist between meteorites and between meteorites and terrestrial rocks. These isotopic variations are caused by differences in the chemical and physical histories of the materials, and should be investigated. An ancillary benefit of this work is the building up at this University of a group of people capable of performing detailed and skilled investigations on lunar material when this is available.

DISCIPLINE: Planetology

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Solid state physics

TITLE: Extreme UV photon absorption in solids

PRINCIPAL INVESTIGATOR: W. C. Walker

ORGANIZATION: University of California
Santa Barbara, California

CONTRACT NUMBER: NsG 91 (Suppl. 1)

TIME PERIOD: 1 Oct. 1962 - 30 Sept. 1963
plus no cost extension to
31 Dec. 1963

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$52,731

TECHNICAL MONITOR: E. J. Ott

ALTERNATE CONTACT: N. G. Roman

DESCRIPTION: Investigate the UV photon absorption properties of various solid materials.

DISCIPLINE: Astronomy

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Planetary Atmospheres

TITLE: Interactions of vacuum ultraviolet radiation

PRINCIPAL INVESTIGATOR: G. L. Weissler

ORGANIZATION: University of Southern California
Los Angeles, California

CONTRACT NUMBER: NsG 178 (Suppl. 1)

TIME PERIOD: 1 Oct. 1962 - 30 Sept. 1965

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$170,000

TECHNICAL MONITOR: D. P. Easter

DESCRIPTION: Basic research concerning the interaction in vacuum of photons in the ultraviolet region (100-1000 Å) with solids. This program contributes to knowledge of the photochemical and photoelectric changes that occur when solar UV and soft X-ray radiation impinges on constituents of planetary atmospheres.

DISCIPLINE: Planetary Atmospheres

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Neurological and Biochemical Bases
of Behavior

TITLE: An experimental investigation of the
role of experiences in the etiology
of animal and human physiological
and behavioral responses to situational
stress in later life.

PRINCIPAL INVESTIGATOR: J. P. Henry and J. P. Meehan

ORGANIZATION: University of Southern California
Los Angeles, California

CONTRACT NUMBER: NsG 433

TIME PERIOD: 1 July 1963 - 30 June 1964

FUNDED BY: Bioscience Programs

AMOUNT: \$104,073

TECHNICAL MONITOR: R. E. Belleville

DESCRIPTION: This task is aimed at assessing the
role that early experience plays in
the etiology of physiological and
behavioral responsiveness to
situational stress.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Communications

TITLE: Study of interference of communication satellites with radio astronomy

PRINCIPAL INVESTIGATOR: Phillip Rice

ORGANIZATION: National Bureau of Standards, CRPL
Boulder, Colorado

CONTRACT NUMBER: R 67

TIME PERIOD: 19 June 1962 - 31 May 1964

FUNDED BY: Communications Programs

AMOUNT: \$65,000

TECHNICAL MONITOR: A. N. Andrus

ALTERNATE CONTACT: R. Burke

DESCRIPTION: Investigate interference to radio astronomy observations due to operation of communications satellite systems.

DISCIPLINE: Astronomy

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Ionosphere & Radio Physics

TITLE: Initiate studies of solar cosmic ray emission events, by ionospheric forward scatter observations in the Antarctic during the IQSY

PRINCIPAL INVESTIGATOR: D. K. Bailey

ORGANIZATION: National Bureau of Standards
Boulder, Colorado

CONTRACT NUMBER: R 74

TIME PERIOD: 29 Nov. 1962 - 28 Nov. 1963

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$25,000

TECHNICAL MONITOR: A. G. Opp

DESCRIPTION: Support of studies of solar cosmic ray emission events, by ionospheric forward scatter observations in the Antarctic during IQSY. This initial funding will be used primarily for the design, construction and purchase of long-lead-time experimental apparatus.

DISCIPLINE: Ionospheres & Radio Physics (prime)
Particles & Fields

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Ionosphere and Radio Physics

TITLE: Incoherent radar backscatter

PRINCIPAL INVESTIGATOR: K. L. Bowles

ORGANIZATION: National Bureau of Standards
Boulder, Colorado

CONTRACT NUMBER: R 83

TIME PERIOD: 7 Feb. 1963 - 6 Feb. 1964

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$200,000

TECHNICAL MONITOR: A. G. Opp

ALTERNATE CONTACT: J. W. Freeman

DESCRIPTION: A high power transmitter at 50 megacycles with a large high gain antenna enables the reception of incoherently back-scattered energy from the ionosphere. Measurement of the received power as a function of altitude, and the spectrum of the echoes enable these parameters to be measured. To a first approximation, the backscattered power as a function of altitude gives the electron-density-height profiles, and the width of the power spectrum gives the ratio of electron to ion temperature.

DISCIPLINE: Ionospheres & Radio Physics

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Ionospheres & Radio Physics

TITLE: Electron content, irregularities,
and density profiles

PRINCIPAL INVESTIGATOR: R. S. Lawrence

ORGANIZATION: National Bureau of Standards
Central Radio Propagation Laboratory
Boulder, Colorado

CONTRACT NUMBER: R 101

TIME PERIOD: 1 July 1963 - 30 June 1964

FINDED BY: Geophysics & Astronomy Programs

AMOUNT: \$142,000

TECHNICAL MONITOR: A. G. Opp

ALTERNATE CONTACT: J. W. Freeman

DESCRIPTION: Owing to the highly eccentric orbit of the EGO satellite, the electron content can be obtained as a function of altitude by measuring dispersive doppler frequency shifts and Faraday rotation. In addition, information is obtained on irregularities by examining the fine structure of the records. Suitably spaced receivers on the ground provide information on the altitude and dimensions of small scale irregularities.

DISCIPLINE: Ionospheres & Radio Physics

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Sun-earth relations

TITLE: Solar monitoring network

PRINCIPAL INVESTIGATOR: J. V. Lincoln

ORGANIZATION: National Bureau of Standards
Boulder, Colorado

CONTRACT NUMBER: R-102

TIME PERIOD: 1 July 1963 - 30 June 1964

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$75,000

TECHNICAL MONITOR: H. J. Smith

DESCRIPTION: From any one place it is impossible to observe the sun throughout a 24 hour period. To correlate effects measured on satellites and probes it is necessary to have worldwide ground-based network of observation stations. The present work is to partially support such a network.

DISCIPLINE: Solar Physics

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Balloon-based Astronomy

TITLE: Atmospheric research for balloon flights

PRINCIPAL INVESTIGATOR: W. O. Roberts

ORGANIZATION: University Corporation for Atmospheric Research
Boulder, Colorado

CONTRACT NUMBER: NASr 185

TIME PERIOD: 12 July 1963 - 31 May 1964

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$175,000

TECHNICAL MONITOR: E. A. Gaugler

DESCRIPTION: Studies of planetary atmosphere and lunar photography.

DISCIPLINE: Planetary Atmospheres (prime)
Planetology

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Solar Physics

TITLE Design of a coronagraph for satellite use

PRINCIPAL INVESTIGATOR: Gordon Newkirk

ORGANIZATION: University Corporation for Atmospheric Research
Boulder, Colorado

CONTRACT NUMBER: NsG 404

TIME PERIOD: 1 March 1963 - 29 Feb. 1964

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$20,000

TECHNICAL MONITOR: H. J. Smith

DESCRIPTION: An externally occulting solar coronagraph was flown through stratospheric altitudes by the High Altitude Observatory in 1960 (Project Coronascope) Such an instrument characterized by very low scattered light would make optimum use of the solar pointing capability of the planned AOSO. The feasibility of a remote operation of a coronagraph in a hostile environment has been successfully demonstrated by the High Altitude Observatory balloon flights. Further development necessary for the adaptation of the device to advanced satellite employment includes the continued reduction of instrument-scattered light, adaptation to satellite launch stresses, and design of photoelectric scanning and electric data handling capabilities. The proposed instrument would embody a system enabling it to record photoelectrically three polarization

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Solar Physics (Contd.)

polarimeters of coronal light;
namely intensity, degree of polari-
zation, and polarization angle
within a region of a few minutes of
the solar limb to about six solar
radii.

DISCIPLINE: Solar Physics

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Planetary Atmospheres

TITLE: Zodiacal light and airglow

PRINCIPAL INVESTIGATOR: F. E. Roach

ORGANIZATION: National Bureau of Standards
Boulder, Colorado

CONTRACT NUMBER: R 18 (Amd. 2)

TIME PERIOD: 18 Feb. 1963 - 18 Feb. 1965

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$78,000

TECHNICAL MONITOR: R. C. Moore

DESCRIPTION: Support of University of Hawaii-
University of Colorado research on
zodiacal light and airglow. In
cooperation with University of
Hawaii (NsG-135)

DISCIPLINE: Astronomy (prime)
Planetary Atmospheres

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Solar UV

TITLE: Solar UV studies

PRINCIPAL INVESTIGATOR: William Rense

ORGANIZATION: University of Colorado
Boulder, Colorado

CONTRACT NUMBER: NASr 86

TIME PERIOD: 15 Nov. 1961 - 30 Nov. 1964

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$250,000

TECHNICAL MONITOR: H. J. Smith

DESCRIPTION: Investigate spectrographically, in space environment, the solar UV radiations (Sounding rocket flight 4.24)

DISCIPLINE: Solar Physics

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Solar Physics

TITLE: Prototype rocket-borne spectrograph
and associated study

PRINCIPAL INVESTIGATOR: T. D. Violette

ORGANIZATION: Western State College of Colorado
Gunnison, Colorado

CONTRACT NUMBER: NsG 311

TIME PERIOD: 19 Sept. 1962 - 19 Mar. 1964

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$35,000

TECHNICAL MONITOR: H. J. Smith

DESCRIPTION: The proposed instrument would cause sufficient resolution to obtain line profiles of the Lyman Beta line and also would be used to study the C III lines at 977A and the lines around 1026A. The core of the Lyman Beta line of H, He I and He II are believed to be determined primarily by "local" conditions of temperature at unit optical depth in the solar atmosphere. The measurement would elucidate the energy equilibrium of the corona and upper chromosphere.

DISCIPLINE: Solar Physics

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Neurological & biochemical bases of behavior

TITLE: Molecular electronic implant stimulator monitor system for behavioral pattern studies

PRINCIPAL INVESTIGATOR: R. Preston

ORGANIZATION: United Aircraft Corp. Systems
Windsor Locks, Connecticut

CONTRACT NUMBER: NASw 542

TIME PERIOD: Oct. 1962 - Nov. 1963

FUNDED BY: Bioscience Programs

AMOUNT: \$192,508

TECHNICAL MONITOR: G. J. Jacobs
W. Menzel (OART)

DESCRIPTION: To develop instrumentation to stimulate the mammalian brain by remote control and telemetry system. The device will include permanent implantation into a monkey with laboratory experimentation.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Celestial Mechanics

TITLE: Research on problems of satellite and
planetary motion

PRINCIPAL INVESTIGATOR: Dirk Brouwer

ORGANIZATION: Yale University
New Haven, Conn.

CONTRACT NUMBER: NsG 29 (Amd. 1)

TIME PERIOD: 1 Aug. 1962 - 1 Aug. 1964

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$342,500

TECHNICAL MONITOR: R. C. Moore

DESCRIPTION: Research on problems of satellite
and planetary motion.

DISCIPLINE: Astronomy

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Solar Physics

TITLE: Investigations of the interaction of
solar flare particles with the
coronal plasma

PRINCIPAL INVESTIGATOR: Ludwig Oster

ORGANIZATION: Yale University
New Haven, Conn.

CONTRACT NUMBER: NsG 176

TIME PERIOD: 1 Nov. 1961 - 31 Oct. 1962
plus no cost extension to
31 Oct. 1963

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$11,955

TECHNICAL MONITOR: H. J. Smith

DESCRIPTION: This research is a theoretical
investigation of the interaction of
solar flare particles with coronal
plasma. The investigation is aimed
at determining whether excitation
of plasma oscillation by the fast
particles may be responsible for
observed non-thermal radio emission.

DISCIPLINE: Solar Physics (prime)
Particles & Fields

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Geochemistry - research in methods and instrumentation

TITLE: Research in gas chromatography

PRINCIPAL INVESTIGATOR: S. R. Lipsky

ORGANIZATION: Yale University
New Haven, Conn.

CONTRACT NUMBER: NsG 192

TIME PERIOD: 1 Aug. 1961 - 31 July 1964

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$97,640

TECHNICAL MONITOR: D. P. Easter

ALTERNATE CONTACT: R. J. Allenby

DESCRIPTION: The purpose of this grant is to conduct research on methods of improving the sensitivity and reliability of gas chromatographs and to design for the Surveyor missions a flight instrument capable of performing extraterrestrial gas and vapor analysis. The instrument's primary purpose will be to help detect organic materials on the lunar surface.

DISCIPLINE: Planetology (prime)
Planetary Atmospheres (prime)

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Evolutionary & Theoretical Biology

TITLE: Studies on extremely small self-replicating systems

PRINCIPAL INVESTIGATOR: H. Morowitz

ORGANIZATION: Yale University
New Haven, Conn.

CONTRACT NUMBER: NsG 208

TIME PERIOD: Nov. 1961 - Oct. 1963

FUNDED BY: Bioscience Program

AMOUNT: \$38,196

TECHNICAL MONITOR: F. H. Quimby

DESCRIPTION: To obtain detailed knowledge of cell systems at the extreme limit of small size, i.e., 0.2 microns. This should be helpful in determining an ultimate criteria for what constitutes a life system. The study will accomplish a characterization of these small cells in terms of size, morphology, chemical composition and soluble macromolecules.

DISCIPLINE : Bioscience

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Geophysics - basic research

TITLE: Internal constitution of the planets

PRINCIPAL INVESTIGATOR: R. Wildt

ORGANIZATION: Yale University
New Haven, Conn.

CONTRACT NUMBER: NsG 312

TIME PERIOD: 1 Oct. 1962 - 30 Sept. 1965

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$117,760

DESCRIPTION: Dr. Wildt will make theoretical studies of the internal constitution of the planets with emphasis on the Jovian planets. Until recently, progress on constructing better planetary models has been blocked by lack of information about the equation of state of solids under high pressure and the thermodynamic properties of such matter. Many of the requisite data can now be obtained by novel experimental techniques only a few years old. Using these new techniques, new models of the Jovian planets will be constructed. This project will also lead to the acquisition of up-to-date astronomical constants relating to the mechanical properties of planetary bodies, i.e., moments of inertia, ellipticities, etc.

DISCIPLINE: Planetology

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Neurological & Biochemical Bases of Behavior

TITLE: Electrophysiological studies of the brain, including improvement of experimental techniques and methodology.

PRINCIPAL INVESTIGATOR: R. Galambos and E. Higgins

ORGANIZATION: Yale University
New Haven, Conn.

CONTRACT NUMBER: NsG 374

TIME PERIOD: 1 April 1963 - 31 March 1964

FUNDED BY: Bioscience Programs

AMOUNT: \$211,534

TECHNICAL MONITOR: R. Belleville

DESCRIPTION: Combined program of neurophysiological research and training.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Lunar geology and geophysics studies

TITLE: Thermal gradient in planetary bodies

PRINCIPAL INVESTIGATOR: S. P. Clark, Jr.

ORGANIZATION: Yale University
New Haven, Conn.

CONTRACT NUMBER: NsG 400

TIME PERIOD: 1 March 1963 - 30 Nov. 1963

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$16,000

TECHNICAL MONITOR: R. P. Bryson

DESCRIPTION: Perturbation of temperature and thermal flux produced by inhomogenetics of thermal conductivity, and the temperature distribution about bodies of crystallizing magmas

DISCIPLINE: Planetology

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Radio and radar planetology studies

TITLE: Decameter wave radiation from Jupiter

PRINCIPAL INVESTIGATOR: H. J. Smith and J. N. Douglas

ORGANIZATION: Yale University
New Haven, Conn.

CONTRACT NUMBER: NsG 407

TIME PERIOD: 1 April 1963 - 31 March 1965

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$83,825

TECHNICAL MONITOR: R. C. Moore

DESCRIPTION: Investigate polarization characteristics of the decametric radiations from Jupiter.

DISCIPLINE: Planetology

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Space chemistry

TITLE: Physical chemistry of comets

PRINCIPAL INVESTIGATOR: Daniel D. Friel

ORGANIZATION: E. I. Dupont de Nemours & Company
Wilmington, Delaware

CONTRACT NUMBER: NASw 707

TIME PERIOD: 23 July 1963 - 22 Jan. 1965

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$96,523

TECHNICAL MONITOR: B. Donn, GSFC

ALTERNATE CONTACT: R. F. Fellows

DESCRIPTION: Research will be conducted to obtain an improved understanding of the chemical composition of comets and to study the mechanism responsible for (a) evaporation of the nucleus (b) formation of the corona, and (c) the origin of observed fluorescence seen as comet glow.

DISCIPLINE: Planetary Atmospheres

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Magnetodynamics

TITLE: Interaction of solar plasma stream
and the geomagnetic field

PRINCIPAL INVESTIGATOR: C. C. Chang

ORGANIZATION: Catholic University
Washington, D.C.

CONTRACT NUMBER: NsG 417

TIME PERIOD: 1 April 1963 - 30 March 1964

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$60,000

TECHNICAL MONITOR: A. Schardt

DESCRIPTION: This grant is for theoretical investigations of: (1) The boundary of the geomagnetic field. (2) Injection trapping, acceleration and decay mechanisms for charged particles in the magnetosphere.

DISCIPLINE: Particles & Fields

SUPPORTING RESEARCH

AREA OF INVESTIGATION: General biological studies and supporting activities

TITLE: Studies in scientific communication research using space-related biology as the subject area

PRINCIPAL INVESTIGATOR: C. W. Shilling

ORGANIZATION: George Washington University
Washington, D. C.

CONTRACT NUMBER: NsG 485

TIME PERIOD: 20 May 1963 - 19 May 1964 .

FUNDED BY: Bioscience Programs

AMOUNT: \$63,440

TECHNICAL MONITOR: Virginia M. Bolton

DESCRIPTION: Under this grant, sources of information useful in and related to space biology will be determined, collected, analyzed, and organized. The work does not fall within the scope of a single program, but supports the research funded in all four Bioscience Program areas.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Ground-based Astronomy

TITLE: Ground-based simulation of Martian spectra

PRINCIPAL INVESTIGATOR: F. J. Heyden

ORGANIZATION: Georgetown University Observatory
Washington, D. C.

CONTRACT NUMBER: NsG 362

TIME PERIOD: 1 March 1963 - 28 Feb. 1965

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$98,769

TECHNICAL MONITOR: R. C. Moore

DESCRIPTION: Obtain transmission spectra of the sun through simulated atmospheres, comparison spectra of the planets, and reflection spectra of the sun from laboratory simulated polar caps crystals.

DISCIPLINE: Planetary Atmospheres (prime)
Planetology

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Instrumentation for detection of extraterrestrial life and life-related compounds

TITLE: Radioisotopic biochemical probe for extraterrestrial life

PRINCIPAL INVESTIGATOR: G. Levin and N. Horowitz

ORGANIZATION: Resources Research, Inc.
Washington, D. C.

CONTRACT NUMBER: NASr 10 (Amd. 4)

TIME PERIOD: 26 Feb. 1963 - 28 Feb. 1964

FUNDED BY: Bioscience Programs

AMOUNT: \$221,034

TECHNICAL MONITOR: F. H. Quimby

DESCRIPTION: To plan an experiment and develop a prototype device to accompany a Martian lander and relay information back to Earth concerning the presence and metabolic activity of microorganisms. The design relies on the production of $C^{14}O_2$ or other radioactive metabolically produced gases from tagged or labelled nutritional substrates in the culture medium.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Vacuum ultraviolet spectroscopy

TITLE: Spectra of trapped atoms and low molecular weight molecules

PRINCIPAL INVESTIGATOR: A. M. Bass

ORGANIZATION: National Bureau of Standards
Washington, D. C.

CONTRACT NUMBER: R 64 (Amd. 1)

TIME PERIOD: 1 June 1963 - 30 Nov. 1964

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$43,500

TECHNICAL MONITOR: H. F. Hipsher

ALTERNATE CONTACT: J. W. Freeman

DESCRIPTION: Studies of the vacuum ultraviolet spectra of atoms and small molecules containing elements such as hydrogen, carbon, nitrogen, and oxygen. Emission and absorption spectra will be observed in both the gas and solid phase.

DISCIPLINE: Planetary Atmospheres

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Radiation physics

TITLE: Far UV radiation physics

PRINCIPAL INVESTIGATOR: R. Madden

ORGANIZATION: National Bureau of Standards
Washington, D. C.

CONTRACT NUMBER: R 73

TIME PERIOD: 1 Nov. 1962 - 30 June 1963
plus no cost extension to
30 June 1964

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$100,000

TECHNICAL MONITOR: N. G. Roman

ALTERNATE CONTACT: E. J. Ott

DESCRIPTION: Investigate the physical properties
of light sources and detectors in
the far UV and soft X-ray regions
and develop radiometric standards in
the same spectral regions.

DISCIPLINE: Astronomy

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Spectroscopy

TITLE: Research on UV spectroscopy using
high temperature plasma sources

PRINCIPAL INVESTIGATOR: Alan C. Kolb

ORGANIZATION: U. S. Navy - Naval Research Laboratory
Washington, D. C.

CONTRACT NUMBER: R 9 (Amd. 2)

TIME PERIOD: 1 March 1963 - 28 Feb. 1966

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$75,000

TECHNICAL MONITOR: E. J. Ott and N. G. Roman

DESCRIPTION: In order to determine the physical
state of a radiating astronomical
source certain laboratory data are
indispensible. This program is for
laboratory research in UV spectroscopy
using high temperature plasma
sources. Simultaneous precision
measurements in both visible and
vacuum UV regions will be made and
results correlated. The result
will be fundamental information on
f-numbers, line widths, etc.

DISCIPLINE: Astronomy

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Solar Physics

TITLE: Coronographs, spectroheliographs,
and high dispersion spectrographs.

PRINCIPAL INVESTIGATOR: H. Friedman

ORGANIZATION: Naval Research Laboratory
Washington, D. C.

CONTRACT NUMBER: R 107

TIME PERIOD: 15 July 1963 - 14 July 1964

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$548,000

TECHNICAL MONITOR: H. J. Smith

DESCRIPTION: Work will be done on the develop-
ment both of components such as
grating filters, etc., and of the
actual instrumentation to be used
on the AOSO satellite. The equip-
ment will include spectroheliographs,
white light coronographs and high
dispersion spectrographs.

DISCIPLINE: Solar Physics

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Biological information, control
and communication systems

TITLE: Basic research in interspecies
communication

PRINCIPAL INVESTIGATOR: J. C. Lilly

ORGANIZATION: Communications Research Institute
Miami, Florida

CONTRACT NUMBER: NsG 278 (Suppl. 1)

TIME PERIOD: 1 July 1963 - 30 September 1963

FUNDED BY: Bioscience Programs

AMOUNT: \$36,475

TECHNICAL MONITOR: R. E. Belleville

ALTERNATE CONTACT: O. E. Reynolds

DESCRIPTION: Develop the steps necessary for the
realization of interspecies communi-
cation and attempt to find the most
probable fertile means of such
communication.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Evolutionary and theoretical biology

TITLE: Space Bioscience Institute

PRINCIPAL INVESTIGATOR: S. Fox

ORGANIZATION: Florida State University
Tallahassee, Florida

CONTRACT NUMBER: NsG 173 and Suppl. 1.

TIME PERIOD: Oct. 1961 - Sept. 1964
1 Oct. 1962 - 30 Sept. 1965

FUNDED BY: Bioscience Programs

AMOUNT: \$784,000
\$550,000

TECHNICAL MONITOR: F. H. Quimby

DESCRIPTION: To conduct experiments on the origin of life, to analyze biochemically samples from terrestrial areas where life or its precursors may have originated, to study lunar samples for evidence of past or terminated prebiochemical development, to study the planetary environments and atmospheres including models and simulation devices, and to prepare experiments for flight in probes and satellites to determine effects of space environments on biological processes. Fox, Hess, and Metz, senior authorities in biochemistry, planetary "meteorology", and biology, respectively, are leading a group of other scientists and technicians in the above and other related work.

DISCIPLINE : Bioscience

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Planetary Atmospheres

TITLE: Study of polarization of the decametre-wave radiation from Jupiter

PRINCIPAL INVESTIGATOR: C. H. Barrow

ORGANIZATION: Florida State University
Tallahassee, Florida

CONTRACT NUMBER: NSG 224 and Suppl. 1.

TIME PERIOD: 1 Feb. 1962 - 31 Jan. 1965
1 Feb. 1963 - 31 Jan. 1965

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$75,409
\$18,739

TECHNICAL MONITOR: R. C. Moore

DESCRIPTION: Objectives of the research program include: (a) Measurement of the magnetic field of Jupiter by observing polarization in the 17 - 27 Mc frequency range. (b) Establishing a model of the Jovian upper atmosphere. (c) Improving the theoretical explanations of the origin of the planet's radiation.

DISCIPLINE: Planetary Atmospheres (prime)
Ionospheres & Radio Physics

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Ground studies of space flight
environmental effects on organisms

TITLE: Conduct research on the effects of
very strong magnetic fields and of
magnetic field free environments on
man and animals

PRINCIPAL INVESTIGATOR: D. E. Beischer

ORGANIZATION: U. S. Naval School of Aviation
Medicine
Pensacola, Florida

CONTRACT NUMBER: R 39 (Amd. 1)

TIME PERIOD: 1 Aug. 1962 - 31 July 1964

FUNDED BY: Bioscience Programs

AMOUNT: \$109,000

TECHNICAL MONITOR: D. W. Jenkins

ALTERNATE CONTACT: R. S. Young, Ames Research Center

DESCRIPTION: Research will involve the study of
organisms under greatly decreased
magnetism or greatly increased
magnetism.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Planetary Atmospheres

TITLE: Submillimeter interference spectrometer

PRINCIPAL INVESTIGATOR: W. K. Rivers, Jr.

ORGANIZATION: Georgia Institute of Technology
Atlanta, Georgia

CONTRACT NUMBER: NsG 258

TIME PERIOD: 1 May 1962 - 31 Oct. 1963

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$104,281

TECHNICAL MONITOR: D. P. Easter

ALTERNATE CONTACT: E. A. Gaugler

DESCRIPTION: An advanced technical development program with the objectives of developing and evaluating a submillimeter interference spectrometer applicable to studies of the electromagnetic properties of materials as a function of wave length.

DISCIPLINE: Planetary Atmospheres

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Upper atmosphere chemical release studies

TITLE: Chemical release studies

PRINCIPAL INVESTIGATOR: H. D. Edwards

ORGANIZATION: Georgia Institute of Technology
Atlanta, Georgia

CONTRACT NUMBER: NSG 304

TIME PERIOD: Sept. 1962 - Sept. 1963

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$93,555

TECHNICAL MONITOR: R. F. Fellows

ALTERNATE CONTACT: H. F. Hipsher

DESCRIPTION: Laboratory and theoretical studies in the application of chemical release techniques to investigations of the upper atmosphere.

DISCIPLINE: Planetary Atmospheres

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Chemical theory

TITLE: Conduct research on chemical reactivity of hydrogen, nitrogen, and oxygen atoms at temperatures below 100°K.

PRINCIPAL INVESTIGATOR: Henry A. McGee, Jr.

ORGANIZATION: Georgia Institute of Technology
Atlanta, Georgia

CONTRACT NUMBER: NsG 337

TIME PERIOD: 1 Dec. 1962 - 30 Nov. 1965

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$72,812

TECHNICAL MONITOR: R. F. Fellows

ALTERNATE CONTACT: H. F. Hipsher

DESCRIPTION: Investigation of the quantitative reactivity of H, O, and N atoms with low molecular weight compounds of C, H, O, and N at temperatures below 100°K. Also investigation of fractional freezing, absorption and adsorption as possible purification techniques for the separation of the unusual product mixtures that are obtained from the cryochemical reactions.

DISCIPLINE: Planetary Atmospheres

SUPPORTING RESEARCH

AREA OF INVESTIGATION: UV instrumentation

TITLE: Design and construct high-speed,
high-resolution spectrograph

PRINCIPAL INVESTIGATOR: H. McAllister

ORGANIZATION: University of Hawaii
Honolulu, Hawaii

CONTRACT NUMBER: NASr 5 (Amd. 1)

TIME PERIOD: 26 March 1963 - 3 Dec. 1963

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$23,440

TECHNICAL MONITOR: H. J. Smith

DESCRIPTION: Conduct design studies and experimental evaluations of a stigmatic spectrograph with nominal dispersion of 1A per millimeter and resolution of 0.01A useful in the spectral range from 1000 to 3000A and of sufficient compactness and speed to be suitable for use in a rocket vehicle.

DISCIPLINE: Solar Physics

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Planetary Atmospheres

TITLE: Zodiacal light and airglow

PRINCIPAL INVESTIGATOR: W. R. Steiger

ORGANIZATION: University of Hawaii
Honolulu, Hawaii

CONTRACT NUMBER: NSG 135

TIME PERIOD: 1 April 1961 - 31 March 1964

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$120,039

TECHNICAL MONITOR: R. C. Moore

DESCRIPTION: Study on zodiacal light selected
lines in the airglow spectrum in
cooperation with NBS Boulder (R 18)

DISCIPLINE: Astronomy (prime)
Planetary Atmospheres

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Solid state physics

TITLE: Emission, conductivity and luminescence of some solids

PRINCIPAL INVESTIGATOR: William Pong and K. Watanabe

ORGANIZATION: Universith of Hawaii
Honolulu, Hawaii

CONTRACT NUMBER: Nsg 328

TIME PERIOD: 1 Oct. 1962 - 30 Sept. 1964

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$95,000

TECHNICAL MONITOR: E. J. Ott

ALTERNATE CONTACT: N. G. Roman

DESCRIPTION: Investigate emission, conductivity, and luminescence properties of solid materials.

DISCIPLINE: Astronomy

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Effects of simulated extraterrestrial environments on earth organisms

TITLE: Research on life in extraterrestrial environments

PRINCIPAL INVESTIGATOR: E. J. Hawrylewicz and R. Ehrlich

ORGANIZATION: Armour Research Foundation
Chicago, Illinois

CONTRACT NUMBER: NASr 22 (Amd. 2)

TIME PERIOD: 3 April 1963-28 Feb. 1964

FUNDED BY: Bioscience Programs

AMOUNT: \$49,139

TECHNICAL MONITOR: D. W. Jenkins

DESCRIPTION: To determine whether plants, particularly bacteria, can grow and survive under simulated Martian conditions.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Planetary Atmospheres

TITLE: Radiative energy transfer on entry
into Mars and Venus

PRINCIPAL INVESTIGATOR: William O. Davies

ORGANIZATION: Armour Research Foundation
Chicago, Illinois

CONTRACT NUMBER: NASr 65(01) (Amd. 2)

TIME PERIOD: 30 Nov. 1962 - 31 Dec. 1963

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$63,589

TECHNICAL MONITOR: D. P. Easter

ALTERNATE CONTACT: E. A. Gaugler

DESCRIPTION: Determination of the carbon dioxide
emission intensity from the 43
micron band at high temperatures;
similar determination in the 2.7
micron region. Investigation of the
reaction rates of processes occurring
behind shock waves in carbon dioxide
nitrogen atmospheres.

DISCIPLINE: Planetary Atmospheres

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Ground studies of space flight
environmental effects on organisms

TITLE: Determine the effects of continuous
three-dimensional rotation of the
Earth's gravitational, magnetic,
and electrical field gradients on
plant morphogenesis.

PRINCIPAL INVESTIGATOR: S. A. Gordon

ORGANIZATION: U. S. Atomic Energy Commission
Argonne National Laboratory
Chicago, Illinois

CONTRACT NUMBER: R 46 (Amd. 1)

TIME PERIOD: 1 Oct. 1962 - 30 June 1964

FUNDED BY: Bioscience Programs

AMOUNT: \$125,000

TECHNICAL MONITOR: D. W. Jenkins

ALTERNATE CONTACT: R. S. Young, Ames Research Center

DESCRIPTION: Determine the effect of rotation of
plants in relation to gravity and
magnetic forces preparatory to
flight studies involving weight-
lessness.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Planetary Atmospheres

TITLE: Dynamics of the upper atmosphere

PRINCIPAL INVESTIGATOR: C. Hines

ORGANIZATION: University of Chicago
Chicago, Illinois

CONTRACT NUMBER: NSG 118 (Suppl. 1)

TIME PERIOD: 1 Jan. 1962 - 31 Dec. 1964

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$100,989

TECHNICAL MONITOR: D. P. Easter

DESCRIPTION: Theoretical study of the dynamics
of the upper atmosphere

DISCIPLINE: Planetary Atmospheres (prime)
Particles & Fields
Ionospheres & Radio Physics

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Energetic particles

TITLE: Composition, energy spectrum, and
intensity of the primary cosmic
radiation as a function of time

PRINCIPAL INVESTIGATOR: Peter Meyer

ORGANIZATION: University of Chicago
Chicago, Illinois

CONTRACT NUMBER: NsG 144 (Suppl.2 and 3)

TIME PERIOD: 2 -1 Nov. 1962 - 31 Oct. 1965
3 -1 March 1963 28 Feb. 1964

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: 2 -\$282,568
3 -\$123,886

TECHNICAL MONITOR: J. W. Freeman

ALTERNATE CONTACT: F. B. McDonald, GSFC

DESCRIPTION: Balloon-borne experiments are
planned to investigate the galactic
and solar cosmic radiation. Satellite
instruments are developed and tested
in these flights.

DISCIPLINE: Particles & Fields

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Energetic particles

TITLE: Experimental and theoretical studies of energetic particles and electro-dynamical processes in interplanetary space and in the vicinity of planets

PRINCIPAL INVESTIGATOR: John Simpson

ORGANIZATION: University of Chicago
Chicago, Illinois

CONTRACT NUMBER: NsG 179 (Suppl. 1)

TIME PERIOD: 1 Aug. 1962 - 31 July 1965

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$254,778

TECHNICAL MONITOR: J. W. Freeman

ALTERNATE CONTACT: F. B. McDonald, GSFC
G. Ludwig, GSFC

DESCRIPTION: This is a three-year step grant for research in galactic and solar cosmic radiation and trapped radiation. Satellite experiments are planned as well as supporting balloon flights.

DISCIPLINE: Particles & Fields

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Solid state physics

TITLE: Image tube research

PRINCIPAL INVESTIGATOR: J. Burns

ORGANIZATION: University of Chicago
Chicago, Illinois

CONTRACT NUMBER: NsG 276 (Suppl. 1)

TIME PERIOD: 1 June 1963 - 31 May 1964

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$70,000

TECHNICAL MONITOR: E. J. Ott

ALTERNATE: N. G. Roman

DESCRIPTION: Determination of future image converter requirements for orbiting observatories, methods for meeting these requirements, and experimental studies of properties of promising image tube materials.

DISCIPLINE: Astronomy

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Meteorite and tektite studies

TITLE: Research program on the origin and age of meteorites

PRINCIPAL INVESTIGATOR: E. Anders

ORGANIZATION: University of Chicago
Chicago, Illinois

CONTRACT NUMBER: NsG 366

TIME PERIOD: 1 Feb. 1963 - 31 Jan. 1964

FUNDED BY: Lunar & Planetary Programs (L&P)
Bioscience Programs (B)

AMOUNT: \$71,000 (L&P)
\$35,000 (B)

TECHNICAL MONITOR: R. J. Allenby

DESCRIPTION: Both the rock age and solar exposure age have been determined for a few meteorites. The determinations indicate a discrepancy between the rock ages of the irons and stones, they also indicate a larger solar exposure age for the irons than the stones. Further work is necessary to resolve and clarify these problems. Dr. Anders specifically proposes to investigate the age of meteorites, their cosmic ray exposure age, and their chemical compositions and phases.

DISCIPLINE: Planetology

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Biophysics and molecular biology

TITLE: Investigations in space-related molecular biology, including consideration of the molecular organization of extraterrestrial matter

PRINCIPAL INVESTIGATOR: H. Fernandez-Moran

ORGANIZATION: University of Chicago
Chicago, Illinois

CONTRACT NUMBER: NsG 441

TIME PERIOD: 1 April 1963 - 31 March 1964

FUNDED BY: Bioscience

AMOUNT: \$198,290

TECHNICAL MONITOR: G. J. Jacobs

DESCRIPTION: Conduct research into molecular organization and behavior of biological systems under controlled space environmental conditions; molecular organization of extraterrestrial matter in the solar system, material from lunar and planetary probes, and interstellar matter.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Electronography

TITLE: Study and evaluation of electronography

PRINCIPAL INVESTIGATOR: W. A. Hiltner, Univ. of Chicago
Leslie Wilcock, Imperial College, London

CONTRACT NUMBER: NsG 546

TIME PERIOD: 1 Sept. 1963 - 31 Dec. 1963

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$9,425

TECHNICAL MONITOR: N. G. Roman

ALTERNATE CONTACT: E. J. Ott

DESCRIPTION: Resolve discrepancies found in the literature for values of the gain of electronography relative to classical photography. These values range from a minimum of 3 to a maximum of about between 10^3 and 10^4 . The investigators will evaluate an electronographic system to determine where the disappointingly small gain has its origin. The efficiency of electron sensitive emulsions for electrons of various energies will be determined. An evaluation of the absolute sensitivity of photographic emulsions will be attempted.

DISCIPLINE: Astronomy

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Ionospheric Physics

TITLE: Ionospheric studies using satellite beacon transmissions

PRINCIPAL INVESTIGATOR: G. W. Swenson, Jr.

ORGANIZATION: University of Illinois

CONTRACT NUMBER: NsG 24 (Suppl. 4)

TIME PERIOD: 1 July 1963 - 30 June 1964

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$119,083

TECHNICAL MONITOR: J. C. Seddon, GSFC

DESCRIPTION: Continuation of work on studying the total electron content of the ionosphere and small-scale irregularities in the F-region by Faraday rotation and differential Doppler measurements. Monitoring stations have been established, personnel trained, and techniques and equipment developed which are expected to be important in conducting the BE-A Ionosphere Beacon Satellite program.

DISCIPLINE: Ionospheres & Radio Physics

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Celestial mechanics

TITLE: Theoretical study of periodic motion and stability in the restricted problem of three bodies.

PRINCIPAL INVESTIGATOR: J. H. Bartlett

ORGANIZATION: University of Illinois
Urbana, Illinois

CONTRACT NUMBER: NsG 280

TIME PERIOD: 1 Aug. 1962 - 31 July 1965

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$48,916

TECHNICAL MONITOR: R. C. Moore

DESCRIPTION: All possible orbits of a particle with small mass under the gravitational attraction of two heavy bodies will be classified and the stability of such motions will be determined.

DISCIPLINE: Astronomy

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Low pressure measurement techniques

TITLE: Theoretical and experimental studies of the underlying processes and techniques of low pressure measurement

PRINCIPAL INVESTIGATOR: Daniel Alpert

ORGANIZATION: University of Illinois
Urbana, Illinois

CONTRACT NUMBER: NsG 376

TIME PERIOD: 1 Dec. 1962 - 30 Nov. 1963

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$106,105

TECHNICAL MONITOR: R. Horowitz

ALTERNATE CONTACT: R. F. Fellows

DESCRIPTION: Principal objectives are: (1) study of the basic physical and chemical processes which play a role in the measurement of low pressures particularly at pressures below 10^{-9} Torr. (2) Search for new and improved methods of measuring gas density, both total molecular density and the density of partial constituents.

DISCIPLINE: Planetary Atmospheres

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Ionospheres & Radio Physics

TITLE: Study to determine the optimum organization and techniques for a world-wide investigation of the D and Lower E Regions of the ionosphere in relation to the IQSY.

PRINCIPAL INVESTIGATOR: S. A. Bowhill

ORGANIZATION: University of Illinois
Urbana-Champaign, Illinois

CONTRACT NUMBER: NsG 379

TIME PERIOD: 1 Feb. 1963 - 31 Jan. 1964

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$27,425

TECHNICAL MONITOR: A. G. Opp

DESCRIPTION: This is a preliminary study which will lead to a series of rocket firings to make coordinated measurements of the lower ionosphere.

DISCIPLINE: Ionospheres & Radio Physics

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Ionospheres & Radio Physics

TITLE: A study of selected radiation and propagation problems related to antennas and probes in magneto-ionic media

PRINCIPAL INVESTIGATOR: G. A. Deschamps, R. Mittra and Y. T. Lo

ORGANIZATION: University of Illinois
Urbana-Champaign, Illinois

CONTRACT NUMBER: NsG 395

TIME PERIOD: 1 April 1963 - 31 March 1964

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$28,930

TECHNICAL MONITOR: A. G. Opp

DESCRIPTION: The detailed behavior of antennas in a magneto-ionic medium is not fully understood, and the solution of this problem is needed in order to make absolute measurements of field strength in the ionosphere, particularly at VLF. The propagation of fields from antennas in wave guides under similar circumstances is of importance in laboratory diagnostics.

DISCIPLINE: Ionospheres & Radio Physics

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Relativity

TITLE: Research selected to an experimental test of general relativity

PRINCIPAL INVESTIGATOR: D. Alpert and H. Knoebel

ORGANIZATION: University of Illinois
Urbana, Illinois

CONTRACT NUMBER: NsG 443

TIME PERIOD: 1 July 1963 - 1 July 1966

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$180,000

TECHNICAL MONITOR: N. G. Roman

DESCRIPTION: An experiment to test the theory of general relativity involves an orbiting gyroscope (Schiff experiment) protected from disturbing torques. Such a gyroscope should precess about 7 arc seconds per year. One way of obtaining a sufficiently stable gyroscope may be the vacuum electrostatic gyroscope being developed at the University of Illinois.

DISCIPLINE: Astronomy

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Experimental analysis of behavior

TITLE: Effects of schedule and stimulus parameters on monitoring and observing behavior

PRINCIPAL INVESTIGATOR: F. C. Clark

ORGANIZATION: Association for Advanced Mental Health
Indianapolis, Indiana

CONTRACT NUMBER: NsG 446

TIME PERIOD: 1 June 1963 - 30 May 1966

FUNDED BY: Bioscience Programs

AMOUNT: \$37,415

TECHNICAL MONITOR: R. E. Belleville

DESCRIPTION: This research is designed to contribute to our knowledge of monitoring behavior through the development of basic information on the nature and interactions of major independent variables. These include signal frequency, signal duration, and reinforcement schedule, which are known to control the probability of signal detection.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Stellar atmospheres

TITLE: Steady-state interaction between
radiation and matter in stellar
atmospheres

PRINCIPAL INVESTIGATOR: Hollis R. Johnson

ORGANIZATION: Indiana University
Bloomington, Indiana

CONTRACT NUMBER: NsG 503

TIME PERIOD: 1 July 1963 - 30 June 1964

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$21,293

TECHNICAL MONITOR: N. G. Roman

DESCRIPTION: Theoretical studies of the steady-
state interaction between radiation
and matter in stellar atmospheres.

DISCIPLINE: Astronomy

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Spectroscopy

TITLE: High precision spectroscopy

PRINCIPAL INVESTIGATOR: K. L. Andrew

ORGANIZATION: Purdue Research Foundation
Lafayette, Indiana

CONTRACT NUMBER: NsG 301

TIME PERIOD: 1 Sept. 1962 - 31 Aug. 1964

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$100,000

TECHNICAL MONITOR: N. G. Roman

ALTERNATE CONTACT: E. J. Ott

DESCRIPTION: High precision spectroscopy with application to the study of atomic spectra of the carbon group and to secondary standards in the vacuum ultraviolet and the development of computer methods of data analysis.

DISCIPLINE: Astronomy

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Energetic particles

TITLE: Theoretical and experimental studies related to the particles and fields associated with the major bodies of the solar system and with inter-planetary space.

PRINCIPAL INVESTIGATOR: J. A. Van Allen

ORGANIZATION: State University of Iowa
Iowa City, Iowa

CONTRACT NUMBER: NsG 233 and Suppl. 1.

TIME PERIOD: B - 1 Nov. 1961 - 31 Oct. 1964
1 - 1 Jan. 1963 - 31 Dec. 1966

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: B - \$ 600,000
1 - \$300,000

TECHNICAL MONITOR: A. W. Schardt

DESCRIPTION: Continuing program of Space Science research including experimental and theoretical studies of trapped radiation and related phenomena.

DISCIPLINE: Particles & Fields

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Radio and radar planetary studies

TITLE: Study earth radar returns from
Alouette satellite

PRINCIPAL INVESTIGATOR: R. K. Moore

ORGANIZATION: University of Kansas
Lawrence, Kansas

CONTRACT NUMBER: NsG 477

TIME PERIOD: 1 May 1963 - 31 April 1964

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$35,000

TECHNICAL MONITOR: E. A. Gaugler

DESCRIPTION: To determine radar cross-section of
specific areas of the Earth at 1000 km.

DISCIPLINE: Planetology (prime)
Ionospheres & Radio Physics

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Effects of the space environment on behavior

TITLE: An experimental investigation of gravity level preference in small animals

PRINCIPAL INVESTIGATOR: K. O. Lange

ORGANIZATION: University of Kentucky
Lexington, Kentucky

CONTRACT NUMBER: NsG 456

TIME PERIOD: 1 May 1963 - 30 April 1964

FUNDED BY: Bioscience Programs

AMOUNT: \$50,000

TECHNICAL MONITOR: R. Belleville

DESCRIPTION: The objectives of this research are twofold: (1) to determine the absolute threshold for linear acceleration (gravity) and to measure changes in sensation of gravity as a function of weightlessness. (2) To assess optimal G. level by allowing biological organisms to select their own gravity environment. The work is directed toward development of experimental equipment for further testing the feasibility of this approach and will provide information leading to the development of a final experimental design. A rotating parabolic surface capable of generating up to 3.2 G will be employed. A radiation detection system for locating the animal in the G field will be developed.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Interplanetary gas and dust

TITLE: Theoretical studies on interplanetary gas and dust

PRINCIPAL INVESTIGATOR: S. F. Singer and E. J. Opik

ORGANIZATION: University of Maryland
College Park, Maryland

CONTRACT NUMBER: NsG 58 (Suppl. 1)

TIME PERIOD: 1 Feb. 1963 - 31 Jan. 1965

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$150,000

TECHNICAL MONITOR: M. Dubin

ALTERNATE CONTACT: R. C. Moore

DESCRIPTION: Detailed theoretical studies of interplanetary dust and gas utilizing available data and newly-acquired information from direct space probe measurements.

DISCIPLINE: Planetary Atmospheres

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Studies of biological materials &
systems for use in space

TITLE: Investigation of phycophysiology in
controlled environments

PRINCIPAL INVESTIGATOR: R. W. Krauss

ORGANIZATION: University of Maryland
College Park, Maryland

CONTRACT NUMBER: NsG 70 (Suppl. 1)

TIME PERIOD: 1 April 1963 - 31 March 1965

FINDED BY: Bioscience Programs

AMOUNT: \$99,250

TECHNICAL MONITOR: D. W. Jenkins

DESCRIPTION: Study the basic physiology of algae
and determine effects of substrate
and environmental factors.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Magnetodynamics

TITLE: Plasma studies

PRINCIPAL INVESTIGATOR: D. A. Tidman

ORGANIZATION: University of Maryland
College Park, Maryland

CONTRACT NUMBER: NsG 220

TIME PERIOD: 1 Feb. 1963 - 31 Jan. 1966

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$97,622

TECHNICAL MONITOR: A. G. Opp

ALTERNATE CONTACT: J. W. Freeman

DESCRIPTION: Dr. Tidman and his collaborators at the University of Maryland are very active in the study of the low density plasmas encountered in interplanetary space. Their studies are primarily theoretical, however, they collaborate at times with experimental plasma studies conducted at GSFC. They work closely with the personnel in the experimental and theoretical division at GSFC. The theoretical studies intended under this grant include studies of the propagation of hydro-magnetic disturbance through plasmas and the study of collisionless shockwaves that have been postulated to exist outside of the geomagnetic boundary.

DISCIPLINE: Particles & Fields (prime)
Ionospheres & Radio Physics

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Plasma Physics

TITLE: Techniques for extraterrestrial
measurement of low energy charged
particle fluxes in the interplanetary
plasma

PRINCIPAL INVESTIGATOR: T. D. Wilkerson

ORGANIZATION: University of Maryland
College Park, Maryland

CONTRACT NUMBER: NsG 283

TIME PERIOD: 1 July 1962 - 30 June 1963
plus no cost extension to
31 Oct. 1963

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$18,179

TECHNICAL MONITOR: J. W. Freeman

DESCRIPTION: Techniques for extraterrestrial
measurement of low energy charged
particle fluxes in the inter-
planetary plasma

DISCIPLINE: Particles & Fields

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Atomic physics

TITLE: Research on measurement of atomic transition probabilities of high temperature gases

PRINCIPAL INVESTIGATOR: T. D. Wilkerson

ORGANIZATION: University of Maryland
College Park, Maryland

CONTRACT NUMBER: NsG 359

TIME PERIOD: 15 Feb. 1963 - 14 Feb. 1964

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$39,702

TECHNICAL MONITOR: N. G. Roman

DESCRIPTION: The data which will be produced by the work is essential to the intelligent interpretation of observations made from rockets and satellites. The first effort at least will be on atomic oscillator strengths which are important astrophysically with emphasis in the visible region. The information gained from this research will be applicable not only to astronomy but to physical chemistry.

DISCIPLINE: Astronomy

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Particles and fields

TITLE: Gravitational radiation

PRINCIPAL INVESTIGATOR: Charles W. Misner and Joseph Weber

ORGANIZATION: University of Maryland
College Park, Maryland

CONTRACT NUMBER: NsG 436

TIME PERIOD: 1 July 1963 - 30 June 1965

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$99,398

TECHNICAL MONITOR: E. A. Gaugler

DESCRIPTION: Study gravitational radiation

DISCIPLINE: Planetology (prime)
Astronomy

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Geology - related to lunar work

TITLE: A study of lunar craters

PRINCIPAL INVESTIGATOR: G. S. Hawkins

ORGANIZATION: Boston University
Boston, Massachusetts

CONTRACT NUMBER: NsG 246 (Suppl. 1)

TIME PERIOD: 1 April 1963 - 31 March 1964

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$14,500

TECHNICAL MONITOR: R. Bryson

DESCRIPTION: This work is an attempt to support the hypothesis that lunar craters have been caused by a bombardment of meteorites over the last 5 billion years. The number and size of the lunar craters will be investigated to see if they are consistent with the number of meteorites which must have collided with the surface during its history.

DISCIPLINE: Planetology

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Evolutionary and theoretical biology

TITLE: A comparative study of the evaluation
of enzymes and nucleic acids

PRINCIPAL INVESTIGATOR: N. Kaplan, L. Levine and J. Marmur

ORGANIZATION: Brandeis University
Waltham, Massachusetts

CONTRACT NUMBER: NsG 375

TIME PERIOD: 1 Feb. 1963 - 31 Jan. 1964

FUNDED BY: Bioscience Programs

AMOUNT: \$110,033

TECHNICAL MONITOR: F. H. Quimby

DESCRIPTION: Investigate the changes that have
occurred in certain enzymes and
nucleic acids isolated from a wide
variety of organisms representing
various stages in the course of
evolution. This will include a
study of the base properties of DNA
in high plants and animals as
contrasted with the DNA of protozoa
and microorganisms.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Planetary Atmospheres

TITLE: Studies in planetary aeronomy

PRINCIPAL INVESTIGATOR: F. F. Marmo

ORGANIZATION: Geophysics Corporation of America
Bedford, Massachusetts

CONTRACT NUMBER: NASw 701 (continuation of NASw 395)

TIME PERIOD: 24 June 1963 - 24 Nov. 1963

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$89,997

TECHNICAL MONITOR: R. F. Fellows

ALTERNATE CONTACT: M. Dubin

DESCRIPTION: Laboratory and theoretical studies in the vacuum ultraviolet including the measurement of absorption spectra and ionization thresholds of possible constituents of planetary atmospheres, the mass analyses of photoionized products and studies of the chemical kinetics of planetary atmospheres.

DISCIPLINE: Planetary Atmospheres

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Planetary Atmospheres

TITLE: The meteorology of Mars & Venus

PRINCIPAL INVESTIGATOR: George Ohring

ORGANIZATION: Geophysics Corporation of America
Bedford, Massachusetts

CONTRACT NUMBER: NASw 704 (continuation of NASw 286)

TIME PERIOD: 13 June 1963 - 12 July 1964

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$67,803

TECHNICAL MONITOR: D. P. Easter

ALTERNATE CONTACT: E. A. Gaugler

DESCRIPTION: Determination of average surface temperature of Mars from radiative equilibrium considerations. In addition, the effects of ozone heating, due to absorption of solar ultraviolet energy, on the temperature profile will be computed. The Venus investigations will be devoted primarily to an evaluation of available information and analysis of existing models of the atmosphere.

DISCIPLINE: Planetary Atmospheres (prime)
Planetology

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Planetary Atmospheres

TITLE: Measurement of the lowest pressures
in space and the laboratory

PRINCIPAL INVESTIGATOR: W. S. Kreisman

ORGANIZATION: Geophysics Corporation of America
Bedford, Massachusetts

CONTRACT NUMBER: NASw 705

TIME PERIOD: 25 March 1963 - 24 April 1964

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$87,418

TECHNICAL MONITOR: R. Horowitz

ALTERNATE CONTACT: R. F. Fellows

DESCRIPTION: A study of the physical processes
occurring at the lowest pressures
attainable in the laboratory to:
(1) Examine experimentally the factors
which limit the attainment of high
vacuum. (2) Provide data needed in
developing new and reliable neutral
particle detectors. (3) Test
existing detectors in a controlled
atmosphere to study their stability,
signal-to-noise characteristics,
etc. (4) Provide design data useful
for building large high vacuum
chambers for space simulation.

DISCIPLINE: Planetary Atmospheres

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Meteors and meteorites

TITLE: Contract to conduct investigations
 of the properties, flux, and
 trajectories of meteors.

PRINCIPAL INVESTIGATOR: Fred L. Whipple

ORGANIZATION: Harvard College Observatory
 Cambridge, Massachusetts

CONTRACT NUMBER: NASr 158

TIME PERIOD: 1 Feb. 1963 - 30 Sept. 1963

FUNDED BY AND AMOUNT: \$265,000 - Office of Advanced
 Research and Technology (OART)
 \$75,000 - Geophysics & Astronomy
 Programs

TECHNICAL MONITOR: C. D'Aiutolo (OART)

ALTERNATE CONTACT: M. Dubin

DESCRIPTION: Using the radio echo technique
 measurements of velocities, decel-
 erations and heights of meteor
 particles (to +12 magnitude) and of
 radiant points will determine meteor
 orbits about the sun. Meteor influx
 rate measurements continuously
 throughout the day and expected
 random variations will provide
 actual numbers of meteoroids
 existing in space that represent
 potential danger to space missions.
 The technique will improve the
 knowledge of ionization efficiency
 of meteors and will provide basic
 data on the theory of high-velocity
 entry.

DISCIPLINE: Planetary Atmospheres

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Geochemistry - research in methods of instrumentation

TITLE: A research program for the study of infrared instrumentation for thermal photography of the moon.

PRINCIPAL INVESTIGATOR: Donald H. Menzel

ORGANIZATION: Harvard University
Cambridge, Massachusetts

CONTRACT NUMBER: NsG 64 (Suppl. 1)

TIME PERIOD: 1 Jan. 1962 - 31 Dec. 1963

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$153,253

TECHNICAL MONITOR: R. C. Moore

DESCRIPTION: The research consists of three parts: (1) Continued development of IR equipment for ground-based observations. (2) Continued development of IR spacecraft instrumentation. (3) Observations of the moon with IR equipment.

DISCIPLINE: Planetology

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Meteorite and tektite studies

TITLE: Mineralogy of stony meteorites

PRINCIPAL INVESTIGATOR: C. Frondel

ORGANIZATION: Harvard University
Cambridge, Massachusetts

CONTRACT NUMBER: NsG 282

TIME PERIOD: 1 July 1962 - 30 June 1965

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$65,865

TECHNICAL MONITOR: R. Bryson

DESCRIPTION: Professor Frondel plans to make a comprehensive study of the minor and accessory constituents of stony meteorites in the Harvard meteorite collection. In addition, there is the possibility of some work being done on the major constituents of stony meteorites. This work will be done largely by standard mineralogic methods; however, microfocus x-ray analysis will be used to analyze small mineral particles in thin sections and polished surfaces.

DISCIPLINE: Planetology

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Solar Physics

TITLE: Theoretical and experimental studies
in ultraviolet solar physics

PRINCIPAL INVESTIGATOR: Leo Goldberg

ORGANIZATION: Harvard University
Cambridge, Massachusetts

CONTRACT NUMBER: NSG 438

TIME PERIOD: 1 Feb. 1963 - 31 Jan. 1966

FUNDED BY: Geophysics & Astronomy Programs

TECHNICAL MONITOR: H. J. Smith

DESCRIPTION: Interpretation of solar spectra in
the ultraviolet involves a knowledge
of atomic spectra in this region.
Laboratory studies are being con-
ducted in this region to define these
spectra. In addition studies are
being made to develop new instru-
mentation to be flown on later OSO's
and particularly on the AOSO
satellite.

DISCIPLINE: Solar Physics

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Instrumentation for detection of extraterrestrial life and life-related compounds

TITLE: Detection and identification of organic matter by mass spectrometry

PRINCIPAL INVESTIGATOR: K. Biemann

ORGANIZATION: Massachusetts Institute of Technology
Cambridge, Massachusetts

CONTRACT NUMBER: NsG 211

TIME PERIOD: Dec. 1961 - Nov. 1964

FUNDED BY: Bioscience Programs

AMOUNT: \$73,117

TECHNICAL MONITOR: F. H. Quimby

DESCRIPTION: To determine the feasibility of identification of life or life related compounds by means of mass spectrometry. Techniques of controlling pyrolysis of samples and determining their mass spectra will be developed. Classes of compounds of interest include amino acids, peptides, carbohydrates, lipids and nucleic acids.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Meteorite and tektite studies

TITLE: Research on tektites

PRINCIPAL INVESTIGATOR: W. H. Pinson

ORGANIZATION: Massachusetts Institute of Technology
Cambridge, Massachusetts

CONTRACT NUMBER: NsG 222

TIME PERIOD: 15 Oct. 1961 - 14 Oct. 1964

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$67,808

TECHNICAL MONITOR: R. Bryson

DESCRIPTION: The formation of tektites apparently cannot be attributed to strictly terrestrial processes, because tektites differ in physical and chemical properties from ordinary terrestrial glass. In an attempt to solve these problems, rubidium-strontium data will be obtained from tektites by mass-spectrometric and neutron activation techniques. Further work will involve the determination of the amounts of other trace elements in tektites of the MIT meteorite collection.

DISCIPLINE: Planetology

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Radio and radar instrument development

TITLE: Flight radar development

PRINCIPAL INVESTIGATOR: J. F. Reintjes

ORGANIZATION: Massachusetts Institute of Technology
Cambridge, Massachusetts

CONTRACT NUMBER: NSG 234 (Suppl.1)

TIME PERIOD: 1 Nov. 1962 - 31 Oct. 1963

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$95,000

TECHNICAL MONITOR: R. C. Moore

DESCRIPTION: Design and development of flight
radar for planetary investigations.

DISCIPLINE: Planetology (prime)
Ionospheres & Radio Physics

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Magnetodynamics

TITLE: Theoretical and experimental investigations of the interplanetary medium and in gamma-ray astronomy

PRINCIPAL INVESTIGATOR: H. Bridge

ORGANIZATION: Massachusetts Institute of Technology
Cambridge, Massachusetts

CONTRACT NUMBER: NsG 386

TIME PERIOD: 1 Jan. 1963 - 31 Dec. 1965

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$500,000

TECHNICAL MONITOR: J. W. Freeman

DESCRIPTION: The MIT group under Rossi and Bridge has had considerable experience in plasma detection including the Explorer X plasma experiment and experiments on the Ranger series of space probes. The experimental phases of this work is directed by Professor Herbert Bridge with the assistance of instrumentation personnel at MIT's Lincoln Laboratories. Design and testing of the plasma sensors is done at MIT's laboratories for nuclear science. In interpretation of the data from the satellite plasma experiments Bridge and Rossi are supported by a large group of theoretical scientists.

DISCIPLINE: Particles & Fields (prime)
Astronomy

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Radio and radar planetary studies

TITLE: Electromagnetic investigation of
planetary atmospheres

PRINCIPAL INVESTIGATOR: A. H. Barrett, J. W. Graham and
R. P. Rafuse

ORGANIZATION: Massachusetts Institute of Technology
Cambridge, Massachusetts

CONTRACT NUMBER: NsG 419

TIME PERIOD: 1 May 1963 - 31 April 1966

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$410,000

TECHNICAL MONITOR: R. C. Moore

ALTERNATE CONTACT: R. F. Fellows

DESCRIPTION: Develop research program in radio
physics of the planets. (This grant
extends the work done under
NsG 250, NsG 264 and NASr 101)

DISCIPLINE: Planetary Atmospheres (prime)
Planetology
Ionospheres & Radio Physics

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Biological information, control and communication systems

TITLE: Partial support of multidisciplinary studies in the neurosciences

PRINCIPAL INVESTIGATOR: F. O. Schmitt

ORGANIZATION: Massachusetts Institute of Technology
Cambridge, Massachusetts

CONTRACT NUMBER: NsG 462

TIME PERIOD: 1 June 1963 - 31 May 1964

FUNDED BY: Bioscience Programs

AMOUNT: \$146,641

TECHNICAL MONITOR: R. E. Belleville

DESCRIPTION: Implement a program of research involving investigations of the "wet" and "dry" biophysics of central nervous system function, i.e., to study the physical basis of long term memory, learning, etc.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Radio astronomy

TITLE: Theoretical antenna problems in
radio astronomy

PRINCIPAL INVESTIGATOR: S. S. Sandler

ORGANIZATION: Northeastern University
Boston, Mass.

CONTRACT NUMBER: NsG 355

TIME PERIOD: 1 July 1963 - 30 June 1964

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$16,837

TECHNICAL MONITOR: E. J. Ott

ALTERNATE CONTACT: N. G. Roman

DESCRIPTION: The extension of present land-based
radio astronomical observations into
space leads to problems in producing
useful structures and in quantitatively
understanding their operations in a
plasma environment. Furthermore the
solution of antenna problems in
space aids in performing a diagnostic
analysis of the plasma problems of
the medium. Specific problems con-
cerned with the operation of the
following devices in the plasma space
environment are to be investigated.
1) Long traveling wave antenna;
2) The synthesis of large reflector
antennas with discrete elements; and
3) The interferometer.

DISCIPLINE: Astronomy

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Meteorite recovery

TITLE: Systematic in-flight photography
and subsequent recovery of meteorites

PRINCIPAL INVESTIGATOR: F. Whipple

ORGANIZATION: Smithsonian Astrophysical Observatory
Boston, Massachusetts

CONTRACT NUMBER: NsG 291

TIME PERIOD: 1 July 1962 - 31 Dec. 1963

FUNDED BY AND AMOUNT: \$120,000 - Bioscience Programs
\$60,000 - Lunar & Planetary Programs
\$59,500 - Geophysics & Astronomy Programs

TECHNICAL MONITOR: M. Dubin

ALTERNATE CONTACT: R. Moore

DESCRIPTION: SAO will install and operate a network of stations in the lower Midwest U.S. covering an area of 10^6 square km with 13 or more stations. Meteors and fireballs of visual magnitude greater than -5 may be photographed by this network. From the photographic data, accurate trajectory and impact point of the meteorite-in-flight may be measured. The photographic measurements will improve the knowledge of luminous efficiency and the meteoritic ablation process as a function of velocity in the atmosphere. From trajectory data, field collection teams will investigate and attempt to recover the fall. The recovered meteorites will subsequently be analyzed in various scientific laboratories for composition, radioactive spallation products, and biochemical content.

DISCIPLINE: Planetary Atmospheres (prime)
Bioscience (prime)
Planetology

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Evolutionary and theoretical biology

TITLE: Synthesis of porphine-like substances from simple precursors under primeval conditions.

PRINCIPAL INVESTIGATOR: A. Szutka

ORGANIZATION: University of Detroit
Detroit, Michigan

CONTRACT NUMBER: NsG 226

TIME PERIOD: Dec. 1961 - Dec. 1964

FUNDED BY: Bioscience Programs

AMOUNT: \$35,640

TECHNICAL MONITOR: F. H. Quimby

DESCRIPTION: Porphine-like substances can be synthesized from pyrrole and aldehydes under the influence of gamma-irradiation. The availability of these as precursors in the primeval conditions can hardly be doubted. This research will use ultra-violet and electrical discharges as sources of energy. The porphines are the basis of respiratory pigments in plants and animals and it is believed that they were active in the very earliest of quasi-living organic structures. They, once formed, can use the energy of visible light in chemical transformations--form complexes readily with metals, and are stable under high temperature and radiation.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Planetary Atmospheres

TITLE: Survey measurements of upper air structure

PRINCIPAL INVESTIGATOR: L. M. Jones

ORGANIZATION: University of Michigan
High Altitude Engineering Laboratory
Ann Arbor, Michigan

CONTRACT NUMBER: NASr 54(05) (formerly NASw 138)

TIME PERIOD: 1 Dec. 1962 - 30 Nov. 1963

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$341,000

TECHNICAL MONITOR: M. Dubin

ALTERNATE CONTACT: R. Horowitz

DESCRIPTION: Paul Massenfilter mass spectrometer for measuring the properties of the upper atmosphere and the conduct of flight tests to obtain atmospheric composition data.

DISCIPLINE: Planetary Atmospheres (prime)
Ionospheres & Radio Physics

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Development of experiments for studies of space flight environmental effects on organisms

TITLE: Research on the effects of earth satellite environment and launching stresses on biological metabolism, including ground-based studies, design and construction of instrumentation for satellite-borne studies, and analysis of the results of the flight experiment.

PRINCIPAL INVESTIGATOR: Allan H. Brown, A. G. Frederickson and H. M. Tsuchiya

ORGANIZATION: University of Minnesota
Minneapolis, Minnesota

CONTRACT NUMBER: NASr 11 (Amd. 3)

TIME PERIOD: 1 May 1963 - 31 Oct. 1963

FUNDED BY: Bioscience Programs

AMOUNT: \$40,356

TECHNICAL MONITOR: D. W. Jenkins

DESCRIPTION: Development of biosatellite experiment to study the effect of weightlessness on respiration and photosynthesis of algae.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Energetic particles

TITLE: Analytical and experimental research
in space physics, including balloon
and rocket flight experiments

PRINCIPAL INVESTIGATOR: J. R. Winckler and E. P. Ney

ORGANIZATION: University of Minnesota
Minneapolis, Minnesota

CONTRACT NUMBER: NsG 281

TIME PERIOD: 1 July 1962 - 30 June 1965

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$800,000

TECHNICAL MONITOR: A. W. Schardt

DESCRIPTION: This is a three year step grant for
research in galactic and solar cosmic
radiation trapped radiation, and
zodiacal light. Satellite experi-
ments are planned as well as
supporting balloon and rocket
flights.

DISCIPLINE: Particles & Fields

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Atmospheric composition

TITLE: Magnetic mass spectrometer research

PRINCIPAL INVESTIGATOR: A. Nier

ORGANIZATION: University of Minnesota
Minneapolis, Minnesota

CONTRACT NUMBER: NsG 286

TIME PERIOD: 1 July 1962 - 30 June 1965

FUNDED BY AND AMOUNT: \$125,000 - Lunar & Planetary Programs
\$98,990 - Geophysics & Astronomy Programs

TECHNICAL MONITOR: D. P. Easter

ALTERNATE CONTACT: R. Horowitz

DESCRIPTION: Experimental research on mass spectro-
meter techniques for the study of
planetary atmospheres, including
laboratory investigation of problems
associated with measuring atomic
oxygen, pumping systems, sampling
problems and instrument design for
both neutral and ionic species.

DISCIPLINE: Planetary Atmospheres

SUPPORTING RESEARCH

AREA OF INVIESTIGATION: Studies of biological materials and systems for use in space

TITLE: Biochemical study of mixed culture algae prototypes in a closed ecological system

PRINCIPAL INVESTIGATOR: R. G. Tischer

ORGANIZATION: Mississippi State University
State College, Mississippi

CONTRACT NUMBER: NsG 80 (Suppl. 2)

TIME PERIOD: 1 July 1963 - 30 June 1966

FUNDED BY: Bioscience Programs

AMOUNT: \$15,000

TECHNICAL MONITOR: D. W. Jenkins

DESCRIPTION: Study treatment of human wastes by use of biological organisms and to convert wastes into useable material for algae.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Studies of biological materials and systems for use in space

TITLE: Physiological effects of weightlessness and space radiations on hibernators

PRINCIPAL INVESTIGATOR: X. J. Musacchia

ORGANIZATION: St. Louis University
St. Louis, Missouri

CONTRACT NUMBER: NsG 271

TIME PERIOD: 1 June 1962 - 31 May 1964

FUNDED BY: Bioscience Programs

AMOUNT: \$17,880

TECHNICAL MONITOR: D. W. Jenkins

DESCRIPTION: To determine protective effect of hibernation by subjecting animals to radiation during space studies.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Energetic particles

TITLE: A determination of some characteristics of high altitude primary cosmic radiation at low and/or southern latitudes

PRINCIPAL INVESTIGATOR: M. W. Friedlander

ORGANIZATION: Washington University
St. Louis, Missouri

CONTRACT NUMBER: NsG 185 (Suppl. 2)

TIME PERIOD: 1 June 1962 - 31 Aug. 1964

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$143,431

TECHNICAL MONITOR: J. W. Freeman

ALTERNATE CONTACT: Carl E. Fichtel, GSFC

DESCRIPTION: Nuclear emulsions are employed in an investigation of primary cosmic radiation at the top of the atmosphere.

DISCIPLINE: Particles & Fields

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Ground studies of space flight
environmental effects on organisms

TITLE: An experimental investigation of the
effects of low pressures on cellular
ultrastructure and cytochemistry
in plants

PRINCIPAL INVESTIGATOR: H. N. Mozingo

ORGANIZATION: University of Nevada
Reno, Nevada

CONTRACT NUMBER: NsG 464

TIME PERIOD: 1 April 1963 - 31 March 1964

FUNDED BY: Bioscience Programs

AMOUNT: \$10,476

TECHNICAL MONITOR: D. W. Jenkins

DESCRIPTION: Study the effects of low pressures
on cellular ultrastructure and
cytochemistry in plants.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Development of experiments for studies of space flight environmental effects on organisms

TITLE: An investigation of the effects of plant growth hormones on plant development in the absence of gravitational effects.

PRINCIPAL INVESTIGATOR: C. J. Lyon

ORGANIZATION: Dartmouth College
Hanover, New Hampshire

CONTRACT NUMBER: NSG 231

TIME PERIOD: 1 Sept. 1962 - 31 Aug. 1964

FUNDED BY: Bioscience Programs

AMOUNT: \$49,906

TECHNICAL MONITOR: D. W. Jenkins

DESCRIPTION: Rotate plants in a clinostat and determine the amount and direction of plant growth movement with relation to gravity.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Magentodynamics

TITLE: Magnetometer research

PRINCIPAL INVESTIGATOR: L. J. Cahill

ORGANIZATION: University of New Hampshire
Durham, New Hampshire

CONTRACT NUMBER: NASw 155 (Amd. 3)

TIME PERIOD: 1 July 1963 - 29 Feb. 1964

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$118,200

TECHNICAL MONITOR: A. G. Opp

ALTERNATE CONTACT: J. W. Freeman

DESCRIPTION: This group has been active in investigation of electrical current in the ionosphere by rocket-borne magnetometers and in studies of the boundary of the magnetosphere by satellite-borne magnetometers. Their present program includes development and testing of various types of magnetometers with the assistance of a recently constructed zero field test facility. Another major portion of the activities is centered on evaluation and interpretation of magnetometer data obtained from successful NASA satellites, Explorer XII, Explorer XIV, and Explorer XV.

DISCIPLINE: Particles & Fields

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Energetic particles

TITLE: Contract for research and development on an instrument suitable for measuring neutron intensity in space

PRINCIPAL INVESTIGATOR: John A. Lockwood

ORGANIZATION: University of New Hampshire
Durham, New Hampshire

CONTRACT NUMBER: NASr 164

TIME PERIOD: 1 April 1963-31 March 1964

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$30,000

TECHNICAL MONITOR: J. W. Freeman

DESCRIPTION: Development of a flight prototype neutron detector suitable for flight on a Javelin rocket or equivalent.

DISCIPLINE: Particles & Fields

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Extraterrestrial sample collection and analysis

TITLE: Hydrocarbon analysis as a means of detecting life in space

PRINCIPAL INVESTIGATOR: W. Meinschein

ORGANIZATION: Esso Research and Engineering
Linden, New Jersey

CONTRACT NUMBER: NASw 508

TIME PERIOD: 1 Jan. 1962 - 31 Dec. 1963

FUNDED BY AND AMOUNT: \$54,000 - Bioscience Programs
\$50,000 - Lunar & Planetary Programs

TECHNICAL MONITOR: F. H. Quimby and D. P. Easter

DESCRIPTION: The assumption underlying this research is that certain stable organic compounds may be the most useful and sensitive indications of life on extraterrestrial bodies. A survey of various natural lipids and the isolation of equivalent compounds from organisms and sediments will be made, including an analysis of their biogenically produced constituents. Also quantitative analyses will be obtained of biogenic hydrocarbons in sediments of different geological ages.

DISCIPLINE: Bioscience (prime)
Planetology

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Instrumentation for detection of extraterrestrial life and life-related compounds

TITLE: Contract for the design and construction of an improved optical microscope system for biological research

PRINCIPAL INVESTIGATOR: Robert D. Allen

ORGANIZATION: Princeton University
Princeton, New Jersey

CONTRACT NUMBER: NASr 159

TIME PERIOD: 15 Jan. 1963 - 31 Jan. 1964

FUNDED BY: Bioscience Programs

AMOUNT: \$35,849

TECHNICAL MONITOR: F. H. Quimby

DESCRIPTION: Research into the design of a microscope which will enable an investigator to observe or photograph specimens in bright or dark field, variable interference phase contrast, or in polarized light.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Astronomy for lunar and planetary investigations

TITLE: The use of television techniques with telescopes above the atmosphere.

PRINCIPAL INVESTIGATOR: M. Schwarzschild

ORGANIZATION: Princeton University
Princeton, New Jersey

CONTRACT NUMBER: NsG 69 (Suppl. 5)

TIME PERIOD: 1 July 1963 - 30 June 1964

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$200,000

TECHNICAL MONITOR: N. G. Roman

ALTERNATE CONTACT: E. J. Ott

DESCRIPTION: For some years to come astronomical instruments above the atmosphere, which promise to revolutionize the entire study of astronomy, will probably be unmanned. To send full information to the ground, television promises to be a most useful tool; both for pointing the instruments at stars, the moon, or planets, and for transmitting the research data to the ground. The purpose of this grant is to design and construct the needed instruments.

DISCIPLINE: Astronomy (prime)
Planetary Atmospheres
Bioscience
Planetology

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Geology - related to lunar work

TITLE: X-ray diffraction studies of lunar-like material

PRINCIPAL INVESTIGATOR: H. H. Hess

ORGNAIZATION: Princeton University
Princeton, New Jersey

CONTRACT NUMBER: NsG 196 (Suppl. 1)

TIME PERIOD: 1 March 1963 - 28 Feb. 1966

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$53,000

TECHNICAL MONITOR: R. J. Allenby

DESCRIPTION: The investigator is preparing X-ray diffraction patterns for various minerals, and mixtures of minerals, that might be found on the lunar surface. This work is in support of the X-ray diffraction experiment for the Surveyor lander.

DISCIPLINE: Planetology

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Spectroscopy

TITLE: Theoretical and/or experimental studies of ultraviolet phenomena of astronomical interest, and of galactic gas dynamics

PRINCIPAL INVESTIGATOR: A. B. Field

ORGANIZATION: Princeton University
Princeton, New Jersey

CONTRACT NUMBER: NsG 414

TIME PERIOD: 1 April 1963 - 31 March 1966

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$222,500

TECHNICAL MONITOR: N. G. Roman

DESCRIPTION: Theoretical studies of the dynamics of the interstellar medium, theoretical studies of the atmospheres of stars, and predictions and interpretations of their spectra in the ultraviolet region. An experimental program to provide laboratory data on the spectra including wave lengths and intensities of molecules and molecular ions is being supported. The molecular ion spectra portion of the program includes a search for unknown ultraviolet spectra of radicals known to be of astrophysical importance. Low resolution studies of continuous absorption coefficients of such low-temperature ices as might reasonably be found in interstellar space, absolute f-value determinations in the ultraviolet of common astrophysical molecules and radicals and, finally, high resolution studies of the intensity in the vacuum ultraviolet of astrophysically interesting

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Spectroscopy (contd)

molecules with unusual isotopic composition will be conducted. All this is sorely needed by many groups participating in the space astronomy program. The work will be in direct support of the OAO programs. Ground-based laboratory information is needed, of course, in order to support data which will be obtained from space-borne instruments.

DISCIPLINE: Astronomy

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Effects of the space environment on behavior

TITLE: An experimental analysis of circadian rhythms under terrestrial conditions, including techniques for studying rhythms in an orbiting satellite

PRINCIPAL INVESTIGATOR: C. S. Pittendrigh

ORGANIZATION: Princeton University
Princeton, New Jersey

CONTRACT NUMBER: NsG 470

TIME PERIOD: 1 May 1963 - 30 April 1964

FUNDED BY: Bioscience Programs

AMOUNT: \$42,926

TECHNICAL MONITOR: R. E. Belleville

DESCRIPTION: A program of ground-based preparatory work in support of a biosatellite experiment will be conducted. The ground-based program falls into two categories. (a) Examination of the suitability of three biological systems for the in-flight experiment. The three potential systems are as follows: (1) Hamster: Rhythm of Body Temperature and (if possible) Locomotion, (2) Cockroach: Rhythm of Locomotion and (if possible) O₂-Consumption. (3) Drosophila: Rhythm of Pupal Eclosion or Adult Activity. (b) Carry out (on the selected system) the necessary ground-based controls on the effects of all known unusual conditions associated with pre-launch, launch, and orbital flight.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Planetary Atmospheres

TITLE: Millimeter wave scanning spectrometer

PRINCIPAL INVESTIGATOR: Richard C. Wertman, Ronald J. Blanchard,
Robert W. Wilmarth

ORGANIZATION: I, T & T
Nutley, New Jersey

CONTRACT NUMBER: NASw 790 (supersedes NASw 430)

TIME PERIOD: 16 July 1963 - 16 Aug. 1964

FUNDED BY: Lunar & Planetary

AMOUNT: \$113,961

TECHNICAL MONITOR: D. P. Easter

ALTERNATE CONTACT: C. A. Barth, JPL

DESCRIPTION: Continue development of millimeter wave scanning spectrometer in accordance with developed theory and experimental information obtained in feasibility study, Phase I. Construct and test backward wave converters in the frequency range of about 50 to 75 gigacycles.

DISCIPLINE: Planetary Atmospheres (prime)
Planetology

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Radar astronomy for lunar investigations

TITLE: Radar reflection from irregular surface

PRINCIPAL INVESTIGATOR: Floyd H. Jean

ORGANIZATION: Dikewood Corporation
Albuquerque, New Mexico

CONTRACT NUMBER: NASw 612

TIME PERIOD: 4 March 1963 - 4 Sept. 1963

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$24,883

TECHNICAL MONITOR: E. A. Gaugler

ALTERNATE CONTACT: W. Brown, JPL

DESCRIPTION: This is a study program with the objective of developing a new mathematical model of radar echo information content for radar mapping of lunar or planetary surface properties.

DISCIPLINE: Planetology (prime)
Ionospheres & Radio Physics

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Astronomy for lunar investigations

TITLE: Continual photographic patrol and study of the physical conditions of the moon and planets.

PRINCIPAL INVESTIGATOR: C. W. Tombaugh

ORGANIZATION: New Mexico State University
University Park, New Mexico

CONTRACT NUMBER: NSG 142 (Suppl. 2)

TIME PERIOD: 15 April 1962 - 14 April 1964

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$188,435

TECHNICAL MONITOR: R. C. Moore

DESCRIPTION: This grant covers photographic, photoelectric, and spectrographic observations and studies of the moon and the planets. The work involves a daily patrol of Venus and Mars. During these patrols sudden and unexpected changes occur in the atmospheres and surfaces of the planets.

DISCIPLINE: Planetology

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Energetic particles

TITLE: Measurement of high energy neutron
flux in space

PRINCIPAL INVESTIGATOR: C. P. Leavitt

ORGANIZATION: University of New Mexico
Albuquerque, New Mexico

CONTRACT NUMBER: NsG 332

TIME PERIOD: 1 May 1963 - 30 April 1964

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$38,732

TECHNICAL MONITOR: J. W. Freeman

DESCRIPTION: A directional neutron detector is
being developed for initial flights
by balloon. Future flights of this
payload on rocket vehicles have been
encouraged.

DISCIPLINE: Particles & Fields

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Magnetodynamics

TITLE: Magnetohydrodynamics and orbit theory (a portion of a research area grant which also includes Lunar surface studies)

PRINCIPAL INVESTIGATOR: T. Gold

ORGANIZATION: Cornell University
Ithaca, New York

CONTRACT NUMBER: NsG 382

TIME PERIOD: 15 Nov. 1962 - 14 Nov. 1965

FUNDED BY AND AMOUNT: \$100,000 - Geophysics & Astronomy Programs
\$100,000 - Lunar & Planetary Programs
\$200,000 - Grants & Research Contracts

TECHNICAL MONITOR: A. Schardt

DESCRIPTION: Theoretical work on (1) the magneto-hydrostatics of the magnetosphere of the earth, and (2) problems in the theory of orbits of space vehicles.

DISCIPLINE: Particles & Fields

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Interplanetary

TITLE: Televised images of gaseous regions
(ionized) in interplanetary space

PRINCIPAL INVESTIGATOR: T. Gold

ORGANIZATION: Cornell University
Ithaca, New York

CONTRACT NUMBER: NSG 471

TIME PERIOD: 1 June 1963 - Feb. 1964

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$11,264

TECHNICAL MONITOR: E. J. Ott

DESCRIPTION: A theoretical and experimental
study of ionized gaseous regions in
interplanetary space.

DISCIPLINE: Particles & Fields (prime)
Astronomy
Solar Physics

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Ionospheres & Radio Physics

TITLE: Topside ionosphere sounder for Mars
and Venus

PRINCIPAL INVESTIGATOR: A. O. Sperber (AIL)
R. W. Knecht (CRPL)
T. Flattau (AIL)

ORGANIZATION: Cutler-Hammer Inc.
(Airborne Instruments Lab.)
Long Island, New York

CONTRACT NUMBER: NASw 513

TIME PERIOD: 5 Sept. 1962 - 4 Sept. 1963

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$78,089

TECHNICAL MONITOR: D. P. Easter

ALTERNATE CONTACT: E. A. Gaugler

DESCRIPTION: The work will be done in cooperation
with CRPL, National Bureau of
Standards, and will consist of
design studies for instrumenting
an experiment to sound the Venus
ionosphere from the "topside"

DISCIPLINE: Ionospheres & Radio Physics (prime)
Planetary Atmospheres

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Extraterrestrial sample collection
and analysis

TITLE: Analysis of carbonaceous meteorites

PRINCIPAL INVESTIGATOR: Bartholomew Nagy
D. J. Hennessy
G. Claus

ORGANIZATION: Fordham University
New York, New York

CONTRACT NUMBER: NsG 341

TIME PERIOD: 1 Nov. 1962 - 31 Oct. 1963

FUNDED BY: Bioscience Programs

AMOUNT: \$109,203

TECHNICAL MONITOR: F. H. Quimby

ALTERNATE CONTACT: R. F. Young (Ames Research Center)

DESCRIPTION: Detailed analysis of the organic and
inorganic components of carbonaceous
and other stony meteorites to ex-
plore further the possibility of
life processes on the parent bodies.
The organic microstructures in car-
bonaceous chondrites will also be
studied.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Energetic particles

TITLE: Cosmic ray research

PRINCIPAL INVESTIGATOR: S. N. Milford

ORGANIZATION: Grumman Aircraft Engineering Corp.
Bethpage, Long Island, New York

CONTRACT NUMBER: NASw 699

TIME PERIOD: 3 July 1963 - 3 July 1964

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$34,692

TECHNICAL MONITOR: J. W. Freeman

DESCRIPTION: To perform a theoretical research program which includes calculation of: (1) the spectrum of elementary particles and radiation produced by collision of cosmic ray particles with interstellar gas particles. (2) The spectrum during decay of the unstable particles. (3) The equilibrium cosmic ray intensity.

DISCIPLINE: Particles & Fields

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Atmospheric photochemistry

TITLE: Photochemistry in the far UV

PRINCIPAL INVESTIGATOR: H. Austin Taylor

ORGANIZATION: New York University
New York, New York

CONTRACT NUMBER: NsG 217

TIME PERIOD: 1 Dec. 1961 - 30 Nov. 1963

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$50,000

TECNICAL MONITOR: R. F. Fellows

DESCRIPTION: A study of the quantum yields and reaction rates in nitric oxide photolysis as a function of pressure, of added nitrogen, of diluents and of wave lengths.

DISCIPLINE: Planetary Atmospheres

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Physiology and space metabolic requirements

TITLE: Development of a superior diet for man-in-space

PRINCIPAL INVESTIGATOR: N. A. Rosenthal

ORGANIZATION: Schwarz Bio-Research Inc.
Orangeburg, New York

CONTRACT NUMBER: NASw 517 (Amd. 1 & 2)

TIME PERIOD: Oct. 1962 - Oct. 1963 plus extension to Sept. 1964

FUNDED BY: Bioscience Programs

AMOUNT: \$183,000
\$133,000 (Amd. 1)
\$188,280 (Amd. 2)

TECHNICAL MONITOR: G. J. Jacobs

DESCRIPTION: To study chemically-defined diets which include essential and non-essential L-Amino and other necessary components (vitamins, minerals, fats, carbohydrates, etc.)

DISCIPLINE: Bioscience

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Interstellar medium

TITLE: Properties of interstellar dust

PRINCIPAL INVESTIGATOR: J. Greenberg

ORGANIZATION: Rensselaer Polytechnic Institute
Troy, New York

CONTRACT NUMBER: NsG 113

TIME PERIOD: 1 Nov. 1960 - 31 Oct. 1963

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$66,900

TECHNICAL MONITOR: N. G. Roman

ALTERNATE CONTACT: E. J. Ott

DESCRIPTION: Investigate properties of the
interstellar dust

DISCIPLINE: Astronomy

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Chemistry of the upper atmosphere

TITLE: Research in fundamental atom chemistry with application to the chemistry of the upper atmosphere

PRINCIPAL INVESTIGATOR: P. Harteck

ORGANIZATION: Rensselaer Polytechnic Institute
Troy, New York

CONTRACT NUMBER: NsG 158

TIME PERIOD: 1 July 1961 - 30 June 1964

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$159,700

TECHNICAL MONITOR: R. F. Fellows

ALTERNATE CONTACT: H. F. Hipsher

DESCRIPTION: The following investigations are being conducted: reactions of O-atoms and N-atoms with each other and also with nitrogen compounds; mechanism of ionization by nitrogen atoms and mechanism of de-excitation of excited nitrogen molecules; and studies of ortho-para systems of symmetrical molecules.

DISCIPLINE: Planetary Atmospheres

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Planetary Atmospheres

TITLE: Laboratory investigations of the composition and chemical behavior of the Venus atmospheres

PRINCIPAL INVESTIGATOR: P. Harteck

ORGANIZATION: Rensselaer Polytechnic Institute
Troy, New York

CONTRACT NUMBER: NsG 261

TIME PERIOD: 1 Aug. 1962 - 31 July 1965

FUNDED BY: lunar & Planetary Programs

AMOUNT: \$151,400

TECHNICAL MONITOR: D. P. Easter

ALTERNATE CONTACT: E. A. Gaugler

DESCRIPTION: Simulated Venus atmosphere will be exposed to various types of radiation and then analyzed chemically, spectroscopically, and mass spectrometrically.

DISCIPLINE: Planetary Atmospheres

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Optical materials

TITLE: Properties of multilayer optical filters

PRINCIPAL INVESTIGATOR: W. Baumeister

ORGANIZATION: University of Rochester
Rochester, New York

CONTRACT NUMBER: NsG 308 (Suppl. 1)

TIME PERIOD: 1 April 1963 - 31 July 1963
plus no cost extension to
30 Nov. 1963

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$13,225

TECHNICAL MONITOR: E. J. Ott

ALTERNATE CONTACT: N. G. Roman

DESCRIPTION: Investigate the properties and design criteria of multilayer optical filters

DISCIPLINE: Astronomy

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Neurological and biochemical bases of behavior

TITLE: Experimental studies of reinforcing brain stimulation, including consideration of behavioral consequences

PRINCIPAL INVESTIGATOR: E. S. Valenstein

ORGANIZATION: Fels Research Institute
Yellow Springs, Ohio

CONTRACT NUMBER: NsG 437

TIME PERIOD: 1 April 1963 - 31 March 1966

FUNDED BY: Bioscience Programs

AMOUNT: \$29,146

TECHNICAL MONITOR: R. E. Belleville

DESCRIPTION: To investigate the inter-related problems concerned with the reinforcing brain stimulation phenomenon. These three problems are: (1) investigation of convenient techniques for screening animals according to reinforcing consequences of brain stimulation; (2) methods of determining stimulus intensity thresholds; and (3) the feasibility of using reinforcing brain stimulation to maintain behavior for prolonged periods of time.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Radar astronomy for lunar investigations

TITLE: Research in lunar surface properties and characteristics

PRINCIPAL INVESTIGATOR: W. L. Hale and T. E. Tice

ORGANIZATION: Ohio State University
Columbus, Ohio

CONTRACT NUMBER: NsG 213 (Amd. 1)

TIME PERIOD: 1 Nov. 1962 - 31 Oct. 1963

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$100,000

TECHNICAL MONITOR: E. A. Gaugler

DESCRIPTION: The work involves a study of the scattering properties of the moon and how these properties are related to its surface structure. The program will include experimental measurement of bistatic scattering from moon-like materials, theoretical studies aimed at providing an interpretation of the model measurements, and participation in actual measurements of lunar scattering properties by passive detection of signals initiated at other transmitting facilities.

DICIPLINE: Planetology (prime)
Ionospheres & Radio Physics

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Ground studies of space flight
environmental effects on organisms

TITLE: Biological effect of chronic
exposure to artificial atmospheres

PRINCIPAL INVESTIGATOR: E. P. Hiatt

ORGANIZATION: Ohio State University
Columbus, Ohio

CONTRACT NUMBER: NsG 295

TIME PERIOD: Sept. 1962 - Aug. 1965

FUNDED BY AND AMOUNT: \$61,219 - Bioscience Programs
\$58,781 - Grants & Research Contracts

TECHNICAL MONITOR: D. W. Jenkins

DESCRIPTION: To investigate effects of prolonged
exposure of small mammals to environ-
ments low in nitrogen, including
control of total pressure, humidity,
temperature and gas composition.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Celestial mechanics

TITLE: Fundamental research in celestial mechanics

PRINCIPAL INVESTIGATOR: P. Herget

ORGANIZATION: University of Cincinnati
Cincinnati, Ohio

CONTRACT NUMBER: NSG 43

TIME PERIOD: 1 Oct. 1959 - 30 Sept. 1962
plus no cost extension to
1 Oct. 1965

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$178,000

TECHNICAL MONITOR: R. C. Moore

DESCRIPTION: Areas under investigation are the determination and survey of periodic Trojan orbits and studies of their stability features; periodic librations about the triangular solutions of the restricted earth-moon problem and their orbital satellites.

DISCIPLINE: Astronomy

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Micrometeorite detection

TITLE: Micrometeorite detection studies

PRINCIPAL INVESTIGATOR: F. C. Todd

ORGANIZATION: Oklahoma State University
Stillwater, Okla.

CONTRACT NUMBER: NASr 7 (Amd. 3)

TIME PERIOD: 1 Oct. 1962 - 30 Sept. 1963

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$56,208

TECHNICAL MONITOR: W. M. Alexander, GSFC

ALTERNATE CONTRACT: M. Dubin

DESCRIPTION: An analytical and limited experimental study of the mechanisms of impact, penetration and light emission for micrometeorites on an aluminum-coated photomultiplier.

DISCIPLINE: Planetary Atmospheres

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Energetic particles

TITLE: Data reduction and analysis for
heavy primary cosmic ray experiment
in Explorer VII satellite.

PRINCIPAL INVESTIGATOR: M. Pomerantz

ORGANIZATION: Bartol Research Foundation
The Franklin Institute
Philadelphia, Pa.

CONTRACT NUMBER: NASr 79 (Amd. 1 & 2)

TIME PERIOD: 1 Nov. 1961 - 30 Sept. 1962
plus no cost extensions to
31 Jan. 1963 & 31 Dec. 1963

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$45,100

TECHNICAL MONITOR: J. W. Freeman

DESCRIPTION: Complete reduction and analysis of
of the ionization chamber data from
the Explorer VII satellite.

DISCIPLINE: Particles & Fields

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SUPPORTING RESEARCH

AREA OF INVESTIGATION: Bioinstrumentation

TITLE: Life science instrumentation

PRINCIPAL INVESTIGATOR: Robert M. Goodman

ORGANIZATION: Franklin Institute
Philadelphia, Pa.

CONTRACT NUMBER: NASr 146

TIME PERIOD: 29 Oct. 1962 - 31 Oct. 1963

FUNDED BY: Bioscience Programs

AMOUNT: \$82,330

TECHNICAL MONITOR: G. J. Jacobs

DESCRIPTION: To provide instrumental systems
suitable for study of circadian
rhythms in small animals (hamsters
and drosophila)

DISCIPLINE: Bioscience

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Meteorite and tektite studies

TITLE: Research on tektites and meteorites,
and radiation damage in related
silicate materials

PRINCIPAL INVESTIGATOR: A. J. Cohen and T. B. Massalski

ORGANIZATION: Mellon Institute
Pittsburgh, Pa.

CONTRACT NUMBER: NsG 57 (Suppl. 1)

TIME PERIOD: 1 Jan. 1962 - 31 Dec. 1963

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$202,902

TECHNICAL MONITOR: R. Bryson

ALTERNATE CONTACT: R. J. Allenby

DESCRIPTION: Dr. A. J. Cohen is studying selected
tektite fields in an attempt to
solve the problem of tektite origins.
He is also studying the radiation
damage in silicate minerals caused
by heating of meteorite impact.
His approach to this problem
involves both field work and geo-
chemical laboratory analysis of
crater-associated materials. Dr.
Massalski is engaged in studies of
the nature, distribution, composition,
and properties of various metallic
and non-metallic phases in the
meteorites.

DISCIPLINE: Planetology

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Ionospheric Physics

TITLE: Ionospheric studies using satellite
beacon transmissions

PRINCIPAL INVESTIGATOR: W. J. Ross

ORGANIZATION: Penn State University
University Park, Pa.

CONTRACT NUMBER: NsG 114 (Suppl. 1)

TIME PERIOD: 1 June 1963 - 31 May 1965

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$161,713

TECHNICAL MONITOR: A. G. Opp

DESCRIPTION: Continue research to determine the
electron content of the ionosphere
by Faraday rotation and differential
Doppler measurements on satellite
signals and studies of the seasonal,
diurnal, and other variations of the
electron content and equivalent slab
thickness.

DISCIPLINE: Ionospheres & Radio Physics

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Ionospheric Physics

TITLE: Study of electron densities in the upper ionosphere based on a separating capsule rocket experiment

PRINCIPAL INVESTIGATOR: J. S. Nisbet

ORGANIZATION: Penn State University
University Park, Pa.

CONTRACT NUMBER: NsG 134 (Suppl. 1 & 2)

TIME PERIOD: 1 - 1 March 1962 - 28 Feb. 1965
2 - 1 March 1963 - 28 Feb. 1966

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: 1 - \$150,000
2 - \$131,608

TECHNICAL MONITOR: A. G. Opp

ALTERNATE CONTACT: R. E. Bourdeau, GSFC

DESCRIPTION: Scientific portion of the program for the development of the separating capsule experiment. This is designed to give accurate, high-resolution electron densities by sending signals between the rocket and the separated capsule.

DISCIPLINE: Ionospheres & Radio Physics

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Biophysics & molecular biology

TITLE: Physics of cellular synthesis, growth and division

PRINCIPAL INVESTIGATOR: E. C. Pollard

ORGANIZATION: Penn State University
University Park, Pa.

CONTRACT NUMBER: NsG 324

TIME PERIOD: Oct. 1962 - Oct. 1963

FUNDED BY: Bioscience Programs

AMOUNT: \$74,969

TECHNICAL MONITOR: G. J. Jacobs

DESCRIPTION: To investigate structural and functional cellular physiology, biophysics, biochemistry and biology insofar as new phenomena and facts are concerned to incorporate these in the theoretical analysis of behavior of the cells and directed towards artificial synthesis of the living cell.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Lunar studies of meteorite impact sites on earth

TITLE: A structural and mineralogical study of meteorite impact craters

PRINCIPAL INVESTIGATOR: O. F. Tuttle

ORGANIZATION: Penn State University
University Park, Pa.

CONTRACT NUMBER: NsG 473

TIME PERIOD: 1 July 1963 - 30 June 1966

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$61,563

TECHNICAL MONITOR: R. P. Bryson

DESCRIPTION: A structural and mineralogical study of meteorite impact craters.

DISCIPLINE: Planetology

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Evolutionary and theoretical biology

TITLE: Conduct research on molecular
biology of nitrogen fixing nodules
in common legumes

PRINCIPAL INVESTIGATOR: Elizabeth Thorogood

ORGANIZATION: University of Pennsylvania
Philadelphia, Pa.

CONTRACT NUMBER: NsG 335

TIME PERIOD: 15 July 1962 - 15 July 1965

FUNDED BY: Bioscience Programs

AMOUNT: \$84,030

TECHNICAL MONITOR: F. H. Quimby

DESCRIPTION: To study the structure and physical
chemistry of nodule hemoproteins and
compare them with vertebrate hemo-
globins and myoglobins. To study
the genetic determinants of hemo-
proteins together with the microbial,
viral (phage) nucleic acids in the
synthesis of the hemoglobins. To
study hydrogenase activity associated
with nitrogen fixation.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Evolutionary and theoretical biology

TITLE: Development of microspectrophotometric instrumentation for the study of pigments and organic molecules within living cells

PRINCIPAL INVESTIGATOR: J. Wolken

ORGANIZATION: University of Pittsburgh
Pittsburgh, Pa.

CONTRACT NUMBER: NsG 230

TIME PERIOD: Jan. 1962 - Dec. 1964

FUNDED BY: Bioscience Programs

AMOUNT: \$61,340

TECHNICAL MONITOR: F. H. Quimby

DESCRIPTION: This is a basic study of photosensitivity in its various widespread forms in nature. The mechanism of photic response is not fully understood at any evolutionary level. Newly developed microspectrophotometric techniques will be applied to appropriate biochemical processes, photosensitive molecules, and pigment systems within plant and animal cells.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Bio-instrumentation

TITLE: Contract to extend the usefulness of cytogenetic methodology as a research technique and as a biomedical monitoring procedure through the utilization of automatic electronic scanning and computer analysis of chromosomes

PRINCIPAL INVESTIGATOR: Niel Wald

ORGANIZATION: University of Pittsburgh
Pittsburgh, Pa.

CONTRACT NUMBER: NASr 169

TIME PERIOD: 1 June 1963 - 30 Nov. 1964

FUNDED BY: Bioscience Programs

AMOUNT: \$125,000

TECHNICAL MONITOR: George J. Jacobs

DESCRIPTION: To extend the usefulness of cytogenetic methodology as a research technique and as a biological monitoring procedure through the utilization of automatic electronic scanning and computer analysis of chromosomes.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Development of experiments for studies of space flight environmental effects on organisms

TITLE: Conduct research directed toward the development of biopaks and experiments for use in a space environment

PRINCIPAL INVESTIGATOR: A. Hollaender

ORGANIZATION: Atomic Energy Commission
Oak Ridge National Laboratory
Oak Ridge, Tennessee

CONTRACT NUMBER: R 60 (Amd. 2)

TIME PERIOD: 1 Jan. 1963 - 30 June 1964

FUNDED BY: Bioscience Programs

AMOUNT: \$150,000

TECHNICAL MONITOR: D. W. Jenkins

DESCRIPTION: A series of experiments with different organisms to study space radiation effects.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Lunar studies of meteorite impact of sites on earth

TITLE: A study of Wells Creek Basin, Tennessee, meteorite impact structure

PRINCIPAL INVESTIGATOR: C. W. Wilson and R. G. Stearns

ORGANIZATION: Vanderbilt University
Nashville, Tennessee

CONTRACT NUMBER: NsG 465

TIME PERIOD: 1 May 1963 - 31 April 1966

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$95,250

TECHNICAL MONITOR: R. P. Bryson

DESCRIPTION: Study of Wells Creek Basin, Tennessee meteorite impact structure.

DISCIPLINE: Planetology

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Energetic particles

TITLE: Cosmic radiation anisotropies

PRINCIPAL INVESTIGATOR: K. McCracken

ORGANIZATION: Graduate Research Center of the
Southwest
Dallas, Texas

CONTRACT NUMBER: NASr 198

TIME PERIOD: 1 July 1963 - 30 June 1964

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$131,140

TECHNICAL MONITOR: J. W. Freeman

DESCRIPTION: To investigate the anisotropies in
the low energy portions of the
proton and alpha particle cosmic
ray spectra, including development
of cosmic ray detectors for a series
of balloon flights and initial
work on prototype satellite detectors.

DISCIPLINE: Particles & Fields

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Geophysics

TITLE: Fundamental research in earth and planetary sciences, including development of advanced scientific experiments in lunar, planetary, and space exploration

PRINCIPAL INVESTIGATOR: L. V. Berkner

ORGANIZATION: Graduate Research Center of the Southwest

ADDRESS: Dallas, Texas

CONTRACT NUMBER: NsG 269 and Suppl. 1.

TIME PERIOD: 1 April 1962 - 31 March 1965

FUNDED BY: Grants & Research Contracts

AMOUNT: \$923,000 and \$425,000

TECHNICAL MONITOR: J. T. Holloway

ALTERNATE CONTACT: D. C. Holmes

DESCRIPTION: This grant is for the support of a broad program of fundamental research in earth and planetary sciences, including development of advanced scientific experiments in lunar, planetary, and space exploration. Supplement is for planetary atmospheres research for: (1) Studies of atmospheric structures; (2) Studies of ionospheric structure; and (3) Studies of atmospheric chemistry.

DISCIPLINE: Planetary Atmospheres (prime)
Planetology

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Geochemistry - related to lunar work

TITLE: Feasibility of neutron analysis of
lunar surface

PRINCIPAL INVESTIGATOR: R. E. Wainerdi

ORGANIZATION: Texas A & M
College Station, Texas

CONTRACT NUMBER: NsG 256 (Suppl. 1)

TIME PERIOD: 1 May 1963 - 30 April 1964

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$102,589

TECHNICAL MONITOR: R. J. Allenby

DESCRIPTION: This grant is to investigate the feasibility of, and design equipment capable of, performing neutron activation analysis of the lunar surface. This work would include a study of the most feasible method of neutron activation, a study of possible neutron sources, and the development of appropriate computer programs for the processing of information from the neutron activation instrumentation.

DISCIPLINE: Planetology

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Development of experiments for studies of space flight environmental effects on organisms

TITLE: An experimental investigation of skeletal mineral losses in humans and pigtail monkeys during immobilization

PRINCIPAL INVESTIGATOR: Pauline B. Mack

ORGANIZATION: Texas Woman's University
Denton, Texas

CONTRACT NUMBER: NsG 440

TIME PERIOD: 1 April 1963 - 31 March 1965

FUNDED BY: Bioscience Programs

AMOUNT: \$88,786

TECHNICAL MONITOR: D. W. Jenkins

DESCRIPTION: Study effect of complete bed rest and zero gravity on calcium loss in skeleton of primates and humans and development of biosatellite experiment.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Geochemistry - research in methods
in instrumentation

TITLE: Research in gas chromatography

PRINCIPAL INVESTIGATOR: James E. Lovelock

ORGANIZATION: University of Houston
Houston, Texas

CONTRACT NUMBER: NSG 199 (Suppl. 1)

TIME PERIOD: 1 Oct. 1962 - 30 Sept. 1964

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$55,084

TECHNICAL MONITOR: D. P. Easter

ALTERNATE CONTACT: E. A. Gaugler

DESCRIPTION: The principle of gas chromatography is that volatiles of different compositions, if swept through a long tube packed with an absorbent material, will arrive separately at the other end. A detection device at the exit end of the tube will identify the volatile compounds. The purpose of this grant is to improve the sensitivity and reliability of the detection device, and to design for the Surveyor missions a flight instrument capable of performing extraterrestrial gas and vapor analysis.

DISCIPLINE: Planetology (prime)
Planetary Atmospheres

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Evolutionary and theoretical biology

TITLE: Organic cosmochemistry

PRINCIPAL INVESTIGATOR: J. Oro

ORGANIZATION: University of Houston
Houston, Texas

CONTRACT NUMBER: NsG 257

TIME PERIOD: May 1962 - May 1965

FUNDED BY: Bioscience Programs

AMOUNT: \$71,250

TECHNICAL MONITOR: F. H. Quimby

DESCRIPTION: To synthesize purines and pyrimidines under possible primitive Earth conditions. Purines and pyrimidines along with ribose and deoxyribose constitute the building blocks of nucleic acids. These are the side groups on the long linear polymer fabricated from a single sugar-phosphate repeating unit.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Theory of spectra

TITLE: Quantum mechanical calculations and studies on atomic systems of astrophysical interest

PRINCIPAL INVESTIGATOR: F. A. Matsen

ORGANIZATION: University of Texas
Austin, Texas

CONTRACT NUMBER: NsG 263 (Suppl. 2)

TIME PERIOD: 1 July 1963 - 30 June 1966

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$102,744

TECHNICAL MONITOR: R. F. Fellows

DESCRIPTION: Calculations of ground and excited state energies and optical transition probabilities for mono and diatomic systems and the investigation of electron cross sections of astrophysical interest.

DISCIPLINE: Planetary Atmospheres (prime)
Solar Physics

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Radio and radar planetary studies

TITLE: Research on millimeter wavelength
radiation from solar bodies

PRINCIPAL INVESTIGATOR: C. W. Tolbert

ORGANIZATION: University of Texas
Austin, Texas

CONTRACT NUMBER: NsG 432 (extension of NASr 87)

TIME PERIOD: 1 April 1963 - 31 March 1964

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$125,000

TECHNICAL MONITOR: R. C. Moore

DESCRIPTION: Research on millimeter wavelength
radiation from solar bodies in
support of solar system probes.

DISCIPLINE: Planetology (prime)
Ionospheres & Radio Physics

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Development of experiments for studies of space flight environmental effects on organisms

TITLE: Research on influence of gravity on unicellular organisms, and optimization of an ultraviolet flying spot microscope for living cell observations

PRINCIPAL INVESTIGATOR: P. O'B. Montgomery

ORGANIZATION: University of Texas
Southwestern Medical School
Dallas, Texas

CONTRACT NUMBER: NsG 210 (Suppl. 1)

TIME PERIOD: 1 Dec. 1962 - 30 Nov. 1965

FUNDED BY: Bioscience Programs

AMOUNT: \$120,000

TECHNICAL MONITOR: D. W. Jenkins

ALTERNATE CONTACT: R. S. Young, Ames Research Center

DESCRIPTION: Study the effect of increased gravity on unicellular organisms including gravities 40,000 to five times normal gravity applied for periods of several hours to several months. The effect of increased gravity on unicellular organisms will be determined by a newly-developed ultraviolet flying spot microscope. This will have application to flight studies in the future.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Studies of biological materials and systems for use in space

TITLE: Conduct an investigation of ecologic relationships between bacteria and algae in photosynthetic gas exchangers

PRINCIPAL INVESTIGATOR: J. E. Moyer and C. H. Ward

ORGANIZATION: USAF-Aerospace Medical Laboratory
Brooks AFB
San Antonio, Texas

CONTRACT NUMBER: R 99

TIME PERIOD: 1 May 1963 - 30 April 1964

FUNDED BY: Bioscience Programs

AMOUNT: \$18,600

TECHNICAL MONITOR: D. W. Jenkins

DESCRIPTION: Study pure algal cultures free of bacterial contamination and to develop and maintain bacterial free cultures.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Effects of the space environment
on behavior

TITLE: A study of temporal factors controlling
animal activity, including consid-
eration of the extent to which
natural rhythms may be changed.

PRINCIPAL INVESTIGATOR: Robert C. Bolles

ORGANIZATION: Hollins College
Hollins College, Virginia

CONTRACT NUMBER: NsG 396

TIME PERIOD: 1 April 1963 - 31 March 1965

FUNDED BY: Bioscience Programs

AMOUNT: \$24,035

TECHNICAL MONITOR: R. E. Belleville

DESCRIPTION: This task includes a series of
studies to determine the extent to
which activity cycles in rats can
be changed from the natural 24-
hour rhythm. This will be done
under conditions of constant
environmental stimulation, and in an
environment providing supporting a-
diurnal cues.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Instrumentation for detection of
extraterrestrial life and life-
related compounds

TITLE: Detection of extraterrestrial life
by optical rotatory dispersion

PRINCIPAL INVESTIGATOR: I. Blei

ORGANIZATION: Melpar, Inc.
Falls Church, Virginia

CONTRACT NUMBER: NASw 557

TIME PERIOD: 20 Dec. 1962 - 20 Dec. 1963

FUNDED BY: Bioscience Programs

AMOUNT: \$92,172

TECHNICAL MONITOR: F. H. Quimby

DESCRIPTION: To determine the feasibility of
detecting extraterrestrial life by
means of rotatory dispersion
profile of pure DNA, including
simple optical rotation in the
2600A UV region.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Instrumentation for detection of extraterrestrial life and life-related compounds

TITLE: Research on detection of extraterrestrial life by ultraviolet spectrophotometry

PRINCIPAL INVESTIGATOR: I. Blei

ORGANIZATION: Melpar, Incorporated
Falls Church, Virginia

CONTRACT NUMBER: NASw 571

TIME PERIOD: 31 Dec. 1962 - 31 Dec. 1963

FUNDED BY: Bioscience Programs

AMOUNT: \$51,142

TECHNICAL MONITOR: F. H. Quimby

DESCRIPTION: Identify the peptide bond by means of its specific absorption at 1850A.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Space chemistry

TITLE: Cometary materials analysis

PRINCIPAL INVESTIGATOR: V. J. DeCarlo

ORGANIZATION: Melpar, Inc.
Falls Church, Virginia

CONTRACT NUMBER: NASw 589

TIME PERIOD: 26 Feb. 1963 - 25 Oct. 1963

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$98,396

TECHNICAL MONITOR: B. Donn, GSFC

ALTERNATE CONTACT: R. F. Fellows

DESCRIPTION: Research studies and investigations directed toward attaining the reproduction of the spectra obtained from observations of natural comets.

DISCIPLINE: Planetary Atmospheres

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Ultraviolet stellar radiation

TITLE: Engineering support of X-15 stabilized platform

PRINCIPAL INVESTIGATOR: R. Seinfeld

ORGANIZATION: Astronautics Corporation of America
Milwaukee, Wisconsin

CONTRACT NUMBER: NASr 143 (Suppl. 1)

TIME PERIOD: 1 October 1962 - 30 September 1964

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$173,597

TECHNICAL MONITOR: E. J. Ott

ALTERNATE CONTACT: N. G. Roman

DESCRIPTION: Provide the engineering support of the ultraviolet photography research being conducted by Prof. Code (Univ. of Wisconsin). Provide field support and install a stable instrumentation platform in the X-15-2 airplane. Also, during the system calibration, fabricate a spare star tracking unit and construct its ancillary field test and alignment equipment.

DISCIPLINE: Astronomy

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Chemical theory

TITLE: Theoretical molecular chemistry

PRINCIPAL INVESTIGATOR: J. O. Hirschfelder

ORGANIZATION: University of Wisconsin
Madison, Wisconsin

CONTRACT NUMBER: NsG 275 and Suppl. 1.

TIME PERIOD: 1 July 1962 - 30 June 1965
1 July 1963 - 30 June 1966

FUNDED BY: Grants & Research Contracts

AMOUNT: \$700,000
\$370,000

TECHNICAL MONITOR: H. Harrison (OART)
J. Holloway
U. Liddel
R. F. Fellows

DESCRIPTION: Conduct program of research in theoretical chemistry, particularly in molecular quantum and statistical mechanics, directed toward determination of the physical and chemical properties of materials, relation of these macroscopic properties of individual molecules and determination of structure and properties of the individual molecules.

DISCIPLINE: Planetary Atmospheres (interest)

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Meteorites and tektites

TITLE: Quantitative investigation of the
mineralogy and petrography of iron
meteorites

PRINCIPAL INVESTIGATOR: E. N. Cameron

ORGANIZATION: University of Wisconsin
Madison, Wisconsin

CONTRACT NUMBER: NsG 439

TIME PERIOD: 1 July 1963 - 30 June 1966

FUNDED BY: Lunar & Planetary Programs

AMOUNT: \$74,225

TECHNICAL MONITOR: R. P. Bryson

DESCRIPTION: Quantitative investigation of the
mineralogy and petrography of iron
and stone meteorites.

DISCIPLINE: Planetology

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Solar Physics

TITLE: Solar patrol at Dominion Observatory

PRINCIPAL INVESTIGATOR: V. Gaizauskas

ORGANIZATION: Dominion Observatory
Ottawa, Canada

CONTRACT NUMBER: NsG 320

TIME PERIOD: 1 Oct. 1962 - 31 March 1964

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$29,000

TECHNICAL MONITOR: H. J. Smith

DESCRIPTION: Monitoring of the solar chromosphere

DISCIPLINE: Solar Physics

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Atomic and molecular spectral studies

TITLE: Laboratory spectroscopy research program

PRINCIPAL INVESTIGATOR: R. W. Nicholls

ORGANIZATION: University of Western Ontario
London, Ontario, Canada

CONTRACT NUMBER: NsG 349

TIME PERIOD: 1 Feb. 1963 - 31 Jan. 1966

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$110,000

TECHNICAL MONITOR: R. F. Fellows

DESCRIPTION: Laboratory studies are to be conducted that will provide basic atomic and molecular data (e.g. wave lengths, identifications, excitation cross-sections, transition probabilities) for atoms and molecules of atmospheric and astrophysical interest. The studies will include the basic excitation mechanisms of these atomic and molecular species. Approximately 50% of the funds will go to provide post-doctoral and pre-doctoral fellowships for work in the above mentioned areas.

DISCIPLINE: Planetary Atmospheres

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Effects of the space environment
on behavior

TITLE: An experimental investigation of
human circadian rhythms, including
consideration of natural and
artificial zeitgeber

PRINCIPAL INVESTIGATOR: J. Aschoff

ORGANIZATION: Max-Planck Institute
Erling-Andechs Uber
Starnsberg/Obb, Germany

CONTRACT NUMBER: NsG 259 & Suppl. 1.

TIME PERIOD: 1 May 1962 - 30 May 1964

FUNDED BY: Bioscience Programs

AMOUNT: \$50,400 plus \$12,500

TECHNICAL MONITOR: R. E. Belleville

DESCRIPTION: To investigate circadian diurnal
rhythms, stimulation on noise level,
light intensity and other phenomena;
to compare single isolated subjects
with group isolated subjects and
related studies.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Meteorites

TITLE: Radar studies of meteors in the
Southern Hemisphere

PRINCIPAL INVESTIGATOR: C. Ellyett

ORGANIZATION: University of Canterbury
Christchurch, C. I., New Zealand

CONTRACT NUMBER: NsG 219 (Suppl. 1.)

TIME PERIOD: 1 Jan. 1963 - 31 Dec. 1964

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$9,000

TECHNICAL MONITOR: M. Dubin

ALTERNATE CONTACT: C. D'Aiutolo - (OART)

DESCRIPTION: Radar studies of Souther Hemisphere
meteors are to be made using a
single transmitter at 69.5 Mc/sec
and a system of three receivers.
The study will determine the ex-
tent of occurrence of minor radiants.
In particular, the distribution of
the sporadic nature of these
radiants is to be compared to the
number of meteors in groupings or
meteor streams.

DISCIPLINE: Planetary Atmospheres

SUPPORTING RESEARCH

AREA OF INVESTIGATION: Solar Physics

TITLE: Monitoring solar activity and
investigating related solar phenomena

PRINCIPAL INVESTIGATOR: Richard A. Miller

ORGANIZATION: Manila Observatory, Philippines

CONTRACT NUMBER: NsG 288

TIME PERIOD: 1 Sept. 1962 - 31 Aug. 1965

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: \$90,000

TECHNICAL MONITOR: H. J. Smith

DESCRIPTION: Ground-based investigation of solar
phenomena and solar monitoring.

DISCIPLINE: Solar Physics

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Astronomy

TITLE: Infrared Astronomy - Theoretical
Studies and Experiment Planning

ORGANIZATION: Ames Research Center

COGNIZANT HEADQUARTERS
OFFICE: Geophysics & Astronomy Programs

LEVEL OF EFFORT: \$20,000

TECHNICAL MONITOR: G. Augason

DESCRIPTION: The extended determination and detailed description of stellar and planetary experiments which can be performed from an infrared OAO, from sounding rockets, and from ground-based observatories. Theoretical studies of processes in stellar atmospheres as they may influence infrared emission and absorption with particular emphasis on proto stars, red giant stars, and late stars on the main sequence. Preparation of methods of data analysis for experiments described. Preparation of catalogues of expected observational results for hypothetical planetary atmospheres based on results of 1-kilometer gas cell absorption studies.

DISCIPLINE: Astronomy (prime)
Planetary Atmospheres

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Astronomy

TITLE: Infrared emission spectroscopy for species of astrophysical interest

ORGANIZATION: Ames Research Center

COGNIZANT HEADQUARTERS OFFICE: Geophysics & Astronomy Programs

LEVEL OF EFFORT: \$50,000

TECHNICAL MONITOR: Jacob Miller

DESCRIPTION: To obtain infrared emission spectra and f-values and damping constants of atoms and molecules of astrophysical interest employing controlled plasma sources, extending determinations and line or band assignments out to 15 microns. Atomic species of interest include N, O, C, H, He and others. Molecular species of interest include CH, OH, NH, CO, CN, C₂, H₂, O₂ as well as metallic hydrides and oxides. Laboratory research facilities, optical and spectroscopic instrumentation and detector systems will be assembled, tested and calibrated to permit these studies. Comparison with visible and ultraviolet spectra of these species will be carried out. To calculate improved wave functions based on those f-value determinations.

DISCIPLINE: Astronomy (prime)
Planetary Atmospheres

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Solar Physics

TITLE: Development of instrumentation techniques capable of producing solar magnetograms with high time resolution.

ORGANIZATION: Ames Research Center

COGNIZANT HEADQUARTERS OFFICE: Geophysics & Astronomy Programs

LEVEL OF EFFORT: \$30,000

TECHNICAL MONITOR: M. Bader

DESCRIPTION: Using a combination of narrow band-pass birefringent filters and a recently developed filter-absorber based on the normal Zeeman effect, together with electronic image intensification techniques, instrumentation will be developed which will be capable of producing solar magnetograms with a time resolution better than ten seconds.

DISCIPLINE: Solar Physics

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Solar Physics

TITLE: Ground-based studies of solar magnetic fields

ORGANIZATION: Ames Research Center

COGNIZANT HEADQUARTERS OFFICE: Geophysics & Astronomy Programs

LEVEL OF EFFORT: \$15,000

TECHNICAL MONITOR: M. Bader

DESCRIPTION: Conduct studies of solar magnetic fields with ground-based equipment and correlate the information obtained with simultaneous optical and radio frequency and magnetic field measurements made on the ground and from earth satellites and deep-space probes.
This task will cover the research on solar magnetic fields to be conducted with such equipment as the Ames High-Time-Resolution spectroheliograph, and will include data acquisition, analysis, and reporting.

DISCIPLINE: Solar Physics

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Solar Physics

TITLE: Solar and stellar atmospheres

ORGANIZATION: Ames Research Center

COGNIZANT HEADQUARTERS
OFFICE: Geophysics & Astronomy Programs

LEVEL OF EFFORT: \$20,000

TECHNICAL MONITOR: J. R. Spreiter

DESCRIPTION: Conduct theoretical studies of models
for solar and stellar atmospheres
to determine chemical composition,
structure, atomic processes, and
dynamic behavior.

DISCIPLINE: Solar Physics (prime)
Astronomy

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Planetary Atmospheres

TITLE: Investigation of gas absorption coefficients and curves of growth for planetary atmospheres.

ORGANIZATION: Ames Research Center

COGNIZANT HEADQUARTERS OFFICE: Lunar & Planetary Programs

LEVEL OF EFFORT: \$175,000

TECHNICAL MONITOR: Jacob Miller and Robert Boese

DESCRIPTION: Determine absorption coefficients and line profiles for gases of interest in planetary atmospheres employing a gas cell (with multiple reflection optics) to achieve optical path lengths up to 1 km. Determine broadening due to temperatures ranging from 77°K to 600°K and due to pressures from 10^{-4} mm Hg to 10 atmospheres. From these data, oscillator strengths (f-values) will be derived and detailed absorption spectra for families of models of planetary atmospheres will be constructed. Further, curves of growth for molecular absorption in planetary atmospheres will be constructed. Data analysis methods applicable to f-values and curves of growth will be worked out and adapted to computer techniques.

DISCIPLINE: Planetary Atmospheres

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Advanced concepts

TITLE: Use of entry capsule motion and heating data to determine atmospheric structure and gas properties of planetary atmospheres.

ORGANIZATION: Ames Research Center

COGNIZANT HEADQUARTERS OFFICE: Lunar & Planetary Programs

LEVEL OF EFFORT: \$25,000

TECHNICAL MONITOR: Alvin Seiff

DESCRIPTION: Study the possible use of motion and heating data from capsules entering planetary atmospheres in the determination of the atmospheric structure and gas properties of those atmospheres.

DISCIPLINE: Planetary Atmospheres

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Space Chemistry

TITLE: Space chemical physics - research studies of processes on planets, on comets and in space

ORGANIZATION: Ames Research Center

COGNIZANT HEADQUARTERS OFFICE: Lunar & Planetary Programs

LEVEL OF EFFORT: \$75,000

TECHNICAL MONITOR: Harold Papazian

DESCRIPTION: Study the chemical physics of formation of chemical complexes, free radicals, and their molecular constitution in interplanetary space, on comets and on the planets as they are influenced by solar radiation, energetic particles, fields, elemental abundances and other environmental parameters. This will involve studies and laboratory measurements of photoionization, dissociation, fluorescence spectra, chemical equilibria, gas absorption on solids, charge exchange as well as rate processes for both homogeneous and heterogeneous reactions.

DISCIPLINE: Planetary Atmospheres (prime)
Planetology

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Planetary Atmospheres

TITLE: Theoretical studies of models for planetary atmospheres

ORGANIZATION: Ames Research Center

COGNIZANT HEADQUARTERS OFFICE: Lunar & Planetary Programs

LEVEL OF EFFORT: \$15,000

TECHNICAL MONITOR: J. R. Spreiter

DESCRIPTION: Conduct theoretical studies of models for planetary atmospheres to determine chemical composition, structure, atomic processes and dynamical behavior. The consequences of various models will be studied in order to eliminate or modify those models which prove to be incompatible with newly acquired data, and to devise new models as it becomes necessary. The types of phenomena to be accounted for by a successful model range from the visible circulation pattern of Jupiter to the polarization of synchotron radiation from Saturn and the bursts of enhanced emission propagated in the whistler mode within the magnetosphere of the earth.

DISCIPLINE: Planetary Atmospheres (prime)
Ionospheres & Radio Physics

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Extraterrestrial sample collection
and analysis

TITLE: Isolation of viruses and bacteria

ORGANIZATION: Ames Research Center

COGNIZANT HEADQUARTERS
OFFICE: Bioscience Programs

LEVEL OF EFFORT: \$10,000

TECHNICAL MONITOR: L. Frommhagen

DESCRIPTION: Examine various systems and pro-
cedures for the isolation of
viruses and bacteria from soil and
atmospheric samples.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Extraterrestrial sample collection
and analysis

TITLE: Analysis of bio-organic material
of extraterrestrial origin

ORGANIZATION: Ames Research Center

COGNIZANT HEADQUARTERS
OFFICE: Bioscience Programs

LEVEL OF EFFORT: \$50,000

TECHNICAL MONITOR: R. S. Young and C. A. Ponnampuruma

DESCRIPTION: Investigate the origin of formed
"fossil-like" bodies found in
meteoritic material which contain
organic chemicals and study organic
compounds in meteorites, as to the
possibility of living origin, and to
compare such materials to natural
and synthetic compounds on earth.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Extraterrestrial sample collection and analysis

TITLE: Provide laboratory and suitable technology for detailed analysis of returned extraterrestrial samples

ORGANIZATION: Ames Research Center

COGNIZANT HEADQUARTERS OFFICE: Bioscience Programs

LEVEL OF EFFORT: \$120,000

TECHNICAL MONITOR: R. S. Young and H. P. Klein

DESCRIPTION: Establish a central laboratory with the required special equipment and techniques to acquire, return and analyze completely, returned extraterrestrial samples from both a biological and biochemical point of view and develop special sampling and handling techniques and, where necessary, analytical techniques.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Instrumentation for detection of
extraterrestrial life and life
related compounds

TITLE: Investigations of life detection
systems

ORGANIZATION: Ames Research Center

COGNIZANT HEADQUARTERS
OFFICE: Bioscience Programs

LEVEL OF EFFORT: \$250,000

TECHNICAL MONITOR: H. P. Klein

DESCRIPTION: Conduct research leading to the
design of suitable life detection
apparatus for possible use on
space vehicles.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Evolutionary and theoretical biology

TITLE: The mechanism of heterocyclic hydroxylation

ORGANIZATION: Ames Research Center

COGNIZANT HEADQUARTERS OFFICE: Bioscience Programs

LEVEL OF EFFORT: \$30,000

TECHNICAL MONITOR: L. Hochstein

DESCRIPTION: Study the mechanism by which oxygen is incorporated into heterocyclic compounds and ascertain how widespread biologically is the heterocyclic mode of hydroxylation. What is the significance of this mode of hydroxylation with respect to the oxidative processes of the cell particularly those concerned with energy capture? Is the hydroxylation of heterocyclic compounds restricted to certain classes of heterocycles or is it widespread?

DISCIPLINE: Bioscience

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Evolutionary and theoretical biology

TITLE: Studies on bacterial adaptation

ORGANIZATION: Ames Research Center

COGNIZANT HEADQUARTERS
OFFICE: Bioscience Programs

LEVEL OF EFFORT: \$20,000

TECHNICAL MONITOR: H. P. Klein

DESCRIPTION: Elucidate the mechanisms by which
bacteria shadow their cellular re-
serve materials into the formation
of new products.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Evolutionary and theoretical biology

TITLE: Study of the origin of cellular organelles

ORGANIZATION: Ames Research Center

COGNIZANT HEADQUARTERS OFFICE: Bioscience Programs

LEVEL OF EFFORT: \$20,000

TECHNICAL MONITOR: H. P. Klein

DESCRIPTION: Determine the mode of synthesis of mitochondria in yeast cells.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Evolutionary and theoretical biology

TITLE: The origin of optical activity

ORGANIZATION: Ames Research Center

COGNIZANT HEADQUARTERS
OFFICE: Bioscience Programs

LEVEL OF EFFORT: \$30,000

TECHNICAL MONITOR: C. A. Ponnampuruma

DESCRIPTION: Find an explanation for the existence
of optical activity in molecules
found in living systems.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Evolutionary and theoretical biology

TITLE: Chemical studies on the origin of life

ORGANIZATION: Ames Research Center

COGNIZANT HEADQUARTERS OFFICE: Bioscience Programs

LEVEL OF EFFORT: \$40,000

TECHNICAL MONITOR: C. A. Ponnampersuma

DESCRIPTION: Study the synthesis of molecules of biological significance on primitive earth conditions and study the possible pathways that may have led to the origin of life on earth.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Evolutionary and theoretical biology

TITLE: The chemistry of planetary atmospheres

ORGANIZATION: Ames Research Center

COGNIZANT HEADQUARTERS
OFFICE: Bioscience Programs

LEVEL OF EFFORT: \$30,000

TECHNICAL MONITOR: C. A. Ponnampерuma

DESCRIPTION: Examine the type of organic
synthesis which can take place in
the atmosphere of Jupiter.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Effects of simulated extraterrestrial environments on earth organisms

TITLE: Studies on the biology of halophilism

ORGANIZATION: Ames Research Center

COGNIZANT HEADQUARTERS OFFICE: Bioscience Programs

LEVEL OF EFFORT: \$31,000

TECHNICAL MONITOR: L. Hochstein

DESCRIPTION: Study the mechanism by which obligate halophilic bacteria grow in environments containing salt concentrations which prove hostile to more familiar forms of life.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Effects of simulated extra-terrestrial environments on earth organisms

TITLE: Effects of simulated planetary environment on earth organisms

ORGANIZATION: Ames Research Center

COGNIZANT HEADQUARTERS OFFICE: Bioscience Programs

LEVEL OF EFFORT: \$100,000

TECHNICAL MONITOR: R. S. Young

DESCRIPTION: Simulate the environments of planets of interest (Mars and Venus) and study the effects of such environments on survival, adaptation, metabolism and growth of micro-organisms such as bacteria, fungi, lichens and algae from extreme environmental conditions. These will be studied in a chamber and maintained at such environmental extremes as will be encountered on Mars (and or Venus).

DISCIPLINE: Bioscience

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Ground studies of space flight
environmental effects on organisms

TITLE: Biological effects of iodizing
radiation on the central nervous
system

ORGANIZATION: Ames Research Center

COGNIZANT HEADQUARTERS
OFFICE: Bioscience Programs

LEVEL OF EFFORT: \$50,000

TECHNICAL MONITOR: J. Miguel et al

DESCRIPTION: Search for new methods for the
detection of radiation injury before
damage is visible morphologically.
This will be combined with specialized
radiation of the central nervous
system.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Ground studies of space flight
environmental effects on organisms

TITLE: Effect of space voyage stress on
in vitro and in vivo metabolic
processes of experimental animals

ORGANIZATION: Ames Research Center

COGNIZANT HEADQUARTERS
OFFICE: Bioscience Programs

LEVEL OF EFFORT: \$50,000

TECHNICAL MONITOR: D. Feller

DESCRIPTION: Determine whether the stresses im-
posed by space voyages on experimental
animals have an effect upon the
synthetic metabolism activity of
isolated organs and tissues and upon
the total body metabolism of attacked
animals.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Ground studies of space flight
environmental effects on organisms

TITLE: Dissociation of certain physiological
components in endodiurnal cycles

ORGANIZATION: Ames Research Center

COGNIZANT HEADQUARTERS
OFFICE: Bioscience Programs

LEVEL OF EFFORT: \$71,000

TECHNICAL MONITOR: C. Winget

DESCRIPTION: Establish the natural period for
certain free running endodirunal
cycles by exposing birds to a
constant light environment.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Ground studies of space flight
environmental effects on organisms

TITLE: Biological effects of altered
gravity state (Centrifugation) on
mammalian organisms

ORGANIZATION: Ames Research Center

COGNIZANT HEADQUARTERS
OFFICE: Bioscience Programs

LEVEL OF EFFORT: \$75,000

TECHNICAL MONITOR: J. Oyama

DESCRIPTION: Adapt a variety of animals to an
altered G environment by prolonged
centrifugation. Study the physiology
of metabolism of this adaptation both
in a positive as well as in a negative
G-loading direction.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Ground studies of space flight
environmental effects on organisms

TITLE: Fundamental studies in the effects
of space radiation on simple
organisms

ORGANIZATION: Ames Research Center

COGNIZANT HEADQUARTERS
OFFICE: Bioscience Programs

LEVEL OF EFFORT: \$45,000

TECHNICAL MONITOR: C. Malich and S. T. Taketa

DESCRIPTION: Determine, with simple organisms,
the effects of particulate radiation
pertinent to Biosatellite experi-
mentation, survival of micro-
organisms in a lunar environment and
genetic changes in interplanetary
space flight and determine environ-
mental factors which influence
radiation-induced mitotic delay in
unicellular organisms.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Ground studies of space flight
environmental effects on organisms

TITLE: Vertebrate brain responses to atomic
radiation

ORGANIZATION: Ames Research Center

**COGNIZANT HEADQUARTERS
OFFICE:** Bioscience Programs

LEVEL OF EFFORT: \$45,000

TECHNICAL MONITOR: W. Haymaker

DESCRIPTION: Study, in monkeys and rats, the
microelectrode recording of nerve
cell and astroglial activity; and
permeability to protein and
fluorescent dyes and radioisotopic
transport.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Ground studies of space flight
environmental effects of organisms

TITLE: Effects of simulated extra-terrestrial
conditions on immune mechanisms and
on mitosis

ORGANIZATION: Ames Research Center

COGNIZANT HEADQUARTERS
OFFICE: Bioscience Programs

LEVEL OF EFFORT: \$30,000

TECHNICAL MONITOR: C. Conley and W. Mills

DESCRIPTION: To determine the effects of high
energy irradiation, cold hypoxia of
the two major modalities of acquired
immune response.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Ground studies of space flight
environmental effects on organisms

TITLE: Effects of high and low magnetic
fields on living material

ORGANIZATION: Ames Research Center

COGNIZANT HEADQUARTERS
OFFICE: Bioscience Programs

LEVEL OF EFFORT: \$10,000

TECHNICAL MONITOR: R. S. Young

DESCRIPTION: To study the effects of controlled
magnetic fields on survival, growth
and metabolism of living organisms.
Maturation and growth rate will be
analyzed in Phycomyces to determine
the mechanism of magnetic field
effects.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Experimental analysis of behavior

TITLE: Control of complex behavior in
infra-human organisms

ORGANIZATION: Ames Research Center

COGNIZANT HEADQUARTERS
OFFICE: Bioscience Programs

LEVEL OF EFFORT: \$30,000

TECHNICAL MONITOR: N. Weissman

DESCRIPTION: Extend experimental control over
total primates behavioral repertory
and explore basic procedures in
complex choice behavior in lower
organisms. The techniques to be
used allow for quantification of
preferences and this in turn permits
greater behavioral control in
experimental animals.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Biochemical bases of behavior

TITLE: Physiology of vestibular nuclei

ORGANIZATION: Ames Research Center

COGNIZANT HEADQUARTERS
OFFICE: Bioscience Programs

LEVEL OF EFFORT: \$30,000

TECHNICAL MONITOR: J. Huertas

DESCRIPTION: Studies will be conducted on the vestibular portion of the stato-acoustic nerve using different techniques and comparing the results by direct electrical stimulation of the vestibular nucleus using stereotaxic techniques; by means of electrical folleys following known afferent pathways; and by depriving the nuclei of their normal afferent impulses.

DISCIPLINE: Bioscience

AREA OF INVESTIGATION: Aerological and biochemical bases of
behavior

TITLE: Biochemical-electrical inter-
relationships in simple biological
information storage systems

ORGANIZATION: Ames Research Center

COGNIZANT HEADQUARTERS
OFFICE: Bioscience Programs

LEVEL OF EFFORT: \$30,000

TECHNICAL MONITOR: J. Shapira

DESCRIPTION: To devise methods to implant
microelectrodes into planaria
ganglia, both in vivo and in vitro.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Effects of the space environment on behavior

TITLE: Behavioral effects of rotation and acceleration

ORGANIZATION: Ames Research Center

COGNIZANT HEADQUARTERS OFFICE: Bioscience Programs

LEVEL OF EFFORT: \$30,000

TECHNICAL MONITOR: N. Weissman

DESCRIPTION: To conduct exploratory experiments on the effects of prolonged exposure to rotation and acceleration on behavioral functions of infra-human organisms.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Evolutionary and theoretical biology

TITLE: Biosynthesis of viruses in cell free systems

ORGANIZATION: Ames Research Center

COGNIZANT HEADQUARTERS OFFICE: Bioscience Programs

LEVEL OF EFFORT: \$10,000

TECHNICAL MONITOR: L. Frommhagen

DESCRIPTION: To demonstrate virus production in certain types of living cells attempts will be made to concentrate and purify the enzymes involved in the synthesis of these products.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Evolution and theoretical biology

TITLE: Structure of nucleic acids of viruses

ORGANIZATION: Ames Research Center

COGNIZANT HEADQUARTERS OFFICE: Bioscience Programs

LEVEL OF EFFORT: \$30,000

TECHNICAL MONITOR: L. Frommhagen

DESCRIPTION: To study the structure of ribonucleic (RNA) and desoxyribonucleic acids (DNA). Certain features of the structure will be probed by the selective use of specific enzymes involved in the metabolism of nucleic acids.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Evolutionary and theoretical biology

TITLE: Lipid involvement in photosynthesis

ORGANIZATION: Ames Research Center

COGNIZANT HEADQUARTERS
OFFICE: Bioscience Programs

LEVEL OF EFFORT: \$25,000

TECHNICAL MONITOR: L. Zill

DESCRIPTION: To isolate and chemically characterize the lipid components of organelles which carry on the photosynthesis process; to determine the chemical and physical properties of these lipids as a basis for their involvement in the structures observed in chloroplastids by electron microscopy, and to determine the enzymic mechanisms responsible for the anabolic and catabolic reactions of these lipids and their possible participation directly in the photosynthesis process.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Evolutionary and theoretical biology

TITLE: Radiation effects on photosynthetic organisms

ORGANIZATION: Ames Research Center

COGNIZANT HEADQUARTERS
OFFICE: Bioscience Programs

LEVEL OF EFFORT: \$25,000

TECHNICAL MONITOR: L. Zill

DESCRIPTION: To determine the effects of intense visible light, and ultraviolet light on the photosynthesis and loss of cellular components by photosynthetic organisms. To determine environmental extremes (terrestrial and extraterrestrial) suitable for photosynthesis. To determine possible mechanisms of origin of photosynthetic systems.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Evolutionary and theoretical biology

TITLE: Factors controlling the formation
and change of hereditary materials

ORGANIZATION: Ames Research Center

COGNIZANT HEADQUARTERS
OFFICE: Bioscience Programs

LEVEL OF EFFORT: \$100,000

TECHNICAL MONITOR: R. Painter

DESCRIPTION: To conduct a comparative study of
genetic systems, how they are
replicated and how they store and
transmit their information.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Evolutionary and theoretical biology

TITLE: Studies of artificial cell membrane

ORGANIZATION: Ames Research Center

COGNIZANT HEADQUARTERS
OFFICE: Bioscience Programs

LEVEL OF EFFORT: \$50,000

TECHNICAL MONITOR: H. Trurnit

DESCRIPTION: To design improved methods for making macroscopic membranes from organic molecules found in natural cell membranes, and to study their properties in the widest possible range.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Evolutionary and theoretical biology

TITLE: Synthesis of protein microspheres to serve as a cell model for research on the origin of life

ORGANIZATION: Ames Research Center

COGNIZANT HEADQUARTERS OFFICE: Bioscience Programs

LEVEL OF EFFORT: \$20,000

TECHNICAL MONITOR: R. S. Young

DESCRIPTION: To synthesize protein molecules and other compounds of biological interest by using thermal co-polymerization of amino acids. Chromatography and mass spectroscopy will be used to analyze the end products.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Studies of biological materials and systems for use in space

TITLE: Incorporation and metabolism of nitrogen by plants

ORGANIZATION: Ames Research Center

COGNIZANT HEADQUARTERS OFFICE: Bioscience Programs

LEVEL OF EFFORT: \$43,000

TECHNICAL MONITOR: K. Yokoyama

DESCRIPTION: Investigate the utilization of nitrogen in the metabolic pathway of a phytological system.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Astronomy

TITLE: Ultraviolet stellar photography

ORGANIZATION: Flight Research Center

COGNIZANT HEADQUARTERS
OFFICE: Geophysics & Astronomy Programs

LEVEL OF EFFORT: \$24,000

TECHNICAL MONITOR: L. P. Thomas

DESCRIPTION: Prepare for ultraviolet stellar photography from aboard the X-15. Necessary preparations include close liaison between the experimenters and the X-15 project personnel and engineering studies associated with the modifications to the X-15 to accommodate the slow tracking and photography equipment; and analog simulator and flight studies of the task to ascertain the piloting problems, display requirements, control requirements reaction control fuel usage, and to establish operational techniques. FRC research will consist of studies of the man-machine combinations required to accomplish the star acquisition and tracking tasks involved in this experiment.

DISCIPLINE: Astronomy

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Magnetodynamics in space

TITLE: Conduct research on low energy
scattering of electrons by atomic
and molecular systems

ORGANIZATION: Goddard Space Flight Center

COGNIZANT HEADQUARTERS
OFFICE: Geophysics & Astronomy Programs

LEVEL OF EFFORT: \$11,519

TECHNICAL MONITOR: A. Levine

DESCRIPTION: Theoretical problems in structure
and scattering in atomic and
molecular physics with relation to
the determination of the opacities
of stellar matter.

DISCIPLINE: Astronomy (interest)
Planetary Atmospheres (interest)
Ionospheres & Radio Physics (interest)

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Astrophysics

TITLE: Calculation of interatomic potentials

ORGANIZATION: Goddard Space Flight Center

COGNIZANT HEADQUARTERS
OFFICE: Geophysics & Astronomy Programs

LEVEL OF EFFORT: \$90,000

TECHNICAL MONITOR: W. N. Hess

DESCRIPTION: Theoretical study of ion-electron recombination. Atomic scattering information is the fundamental ingredient in understanding the upper atmospheric physics of the earth, other planetary atmospheres and astrophysical phenomena. This study is aimed at extending our knowledge on problems of collision cross sections, types of possible reactions and the reaction rates.

DISCIPLINE: Astronomy (prime)
Particles & Fields

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Astronomy

TITLE: Theoretical Studies of Structure of
High Temperature Stars

ORGANIZATION: Goddard Space Flight Center

COGNIZANT HEADQUARTERS
OFFICE: Geophysics & Astronomy Programs

LEVEL OF EFFORT: \$12,000

TECHNICAL MONITOR: J. E. Milligan

DESCRIPTION: Theoretical studies of stellar
structure will consider such
problems as: interior models for
very massive stars, and calculations
on opacity sources in stellar
atmospheres. Models of stellar
atmospheres will be computed and the
emergent stellar flux predicted to
compare with rocket and satellite
data.

DISCIPLINE: Astronomy

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Astronomy

TITLE: Ground-based radio astronomy

ORGANIZATION: Goddard Space Flight Center

COGNIZANT HEADQUARTERS
OFFICE: Geophysics & Astronomy Programs

LEVEL OF EFFORT: \$100,000

TECHNICAL MONITOR: Robert Stone

DESCRIPTION: Ground-based evaluation and test
of instrumentation and antenna con-
cepts for space radio astronomy:
synoptic monitoring of solar and
Jupiter radio emission.

DISCIPLINE: Astronomy (prime)
Solar Physics
Planetary Atmospheres

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Geodesy and Celestial Mechanics

TITLE: Theoretical studies in geodesy and celestial mechanics

ORGANIZATION: Goddard Space Flight Center

COGNIZANT HEADQUARTERS OFFICE: Geophysics & Astronomy Programs

LEVEL OF EFFORT: \$30,000

TECHNICAL MONITOR: W. N. Hess

DESCRIPTION: Develop statistical methods applicable to non-uniformly distributed observations for the purpose of (a) planning the distribution of observations, such as the locations of tracking stations; and (b) extracting the maximum of information from existing data. At present, satellite orbit determination, and the determination of geodetic parameters from orbital perturbations, attain an accuracy which falls short of the accuracy of the observations for two interesting reasons: non-uniform distribution of observations and an inadequate mathematical model of drag perturbations. To exploit observations already made, a theoretically rigorous solution requires a prohibitive amount of computer time. Further theoretical development of modifications of the rigorous solution are therefore needed. To obtain the best distribution of observations economically feasible for future satellites, there is needed a firmer mathematical basis for deciding on tracking station distribution. Logistical considerations also make this a problem in the statistics of non-uniformly distributed observations. Further

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Geodesy and Celestial Mechanics (Contd)

DESCRIPTION:
(Contd.)

development of such methods will result in improved determination of variations in the earth's gravity field and of tracking station positions, and will have as a by-product better determination of satellite positions.

DISCIPLINE: Astronomy

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Solar Physics

TITLE: Theoretical studies of solar flare events.

ORGANIZATION: Goddard Space Flight Center

COGNIZANT HEADQUARTERS OFFICE: Geophysics & Astronomy Programs

LEVEL OF EFFORT: \$65,000

TECHNICAL MONITOR: John C. Lindsay

DESCRIPTION: The task objective is to learn more about the solar flare phenomenon, that is, the energy storage mechanism, the energy release, and the energy transport phenomenon; and to apply new knowledge concerning solar flares to the improvement of solar flare prediction criteria.

DISCIPLINE: Solar Physics

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Solar Physics

TITLE: Solar radiation research

ORGANIZATION: Goddard Space Flight Center

COGNIZANT HEADQUARTERS
OFFICE: Geophysics & Astronomy Programs

LEVEL OF EFFORT: \$426,000

TECHNICAL MONITOR: William A. White

DESCRIPTION: Both soft X-rays and vacuum ultra-violet radiation are absorbed by the earth's atmosphere making it impossible to carry out terrestrial observations in the wavelengths between 1 and 2000Å. Orbiting spacecraft having suitable detectors and means for transmitting the data to earth are required for long-term observations. There is a need for a space-borne solar image reproduction system consisting of a television camera equipped with a special camera tube and optics which will respond to the wavelength regions. The first such system being designed will operate in the 1 to 100Å region.

DISCIPLINE: Solar Physics

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Solar Physics

TITLE: Theoretical studies in stellar and solar physics

ORGANIZATION: Goddard Space Flight Center

COGNIZANT HEADQUARTERS OFFICE: Geophysics & Astronomy Programs

LEVEL OF EFFORT: None (In-house support effort)

TECHNICAL MONITOR: W. N. Hess

DESCRIPTION: Theoretical studies in stellar and solar physics aimed at: (1) understanding the mechanism by which the atoms interact with each other and with radiation, and (2) understanding our environment in relationship to the solar system and eventually gaining some control over our environment by this knowledge.

DISCIPLINE: Solar Physics

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Solar Physics

TITLE: Sun sensor

ORGANIZATION: Goddard Space Flight Center

COGNIZANT HEADQUARTERS
OFFICE: Geophysics & Astronomy Programs

LEVEL OF EFFORT: \$150,000

TECHNICAL MONITOR: Walter Raskin

DESCRIPTION: The sensor proposed will be designed to point the Advanced Orbiting Solar Observatory (AOSO) with great precision. This sun sensor will enable accurate pointing to ± 20.0 arc-seconds over a 40 arc-minute square centered on the sun and ± 20.0 arc-seconds outside the 40 arc-minute square and within a 10 degree square centered on the sun. In addition the sun sensor will be able to generate a 5 arc-minute raster scan anywhere within the 40 arc-minute square centered on the sun, and a 40 arc-minute raster scan anywhere within the 10 degree square.

DISCIPLINE: Solar Physics

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Planetary Atmospheres

TITLE: Atmospheric structure detectors

ORGANIZATION: Goddard Space Flight Center

COGNIZANT HEADQUARTERS
OFFICE: Lunar & Planetary Programs

LEVEL OF EFFORT: \$350,000

TECHNICAL MONITOR: N. W. Spencer

DESCRIPTION: Develop analytical methods to obtain a better understanding of planetary atmospheres and devise concepts for simple experiments and probes which can be flown into these atmospheres. Development of sensors includes pressure gages, temperature gages, gas composition measurement devices, diaphragm gages, mass spectrometers, and optical devices.

DISCIPLINE: Planetary Atmospheres (prime)
Ionospheres & Radio Physics

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Theoretical studies of planetary atmospheres

TITLE: Behavior and composition of planetary atmospheres

ORGANIZATION: Goddard Space Flight Center

COGNIZANT HEADQUARTERS OFFICE: Geophysics & Astronomy Programs

LEVEL OF EFFORT: None (In-house support effort)

TECHNICAL MONITOR: W. N. Hess

DESCRIPTION: This research involves integrating equations describing the dynamical behavior and composition of atmospheres. Recent work has indicated that newly discovered processes are involved in upper atmosphere heating, and it is necessary to develop an appropriate mechanism to explain the behavior of the upper atmosphere.

DISCIPLINE: Planetary Atmospheres

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Atmospheric structure detectors

TITLE: Low current detector components

ORGANIZATION: Goddard Space Flight Center

COGNIZANT HEADQUARTERS
OFFICE: Geophysics & Astronomy Programs

LEVEL OF EFFORT: \$150,000

TECHNICAL MONITOR: N. Spencer

DESCRIPTION: Research and development for fabrication of improved components and techniques associated with ultra-low current detectors used with aeronomy direct measurement sensors. This involves advancing the state of the art of constructing electrometer tubes, high megohm resistors and low current calibration sources.

DISCIPLINE: Planetary Atmospheres

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Atmospheric instruments

TITLE: Detector calibration systems

ORGANIZATION: Goddard Space Flight Center

COGNIZANT HEADQUARTERS
OFFICE: Geophysics & Astronomy Programs

LEVEL OF EFFORT: \$190,000

TECHNICAL MONITOR: N. Spencer

DESCRIPTION: Development of improved calibration systems and experimental techniques for advancing the interpretation of the performance of pressure gages and spectrometers.

DISCIPLINE: Planetary Atmospheres

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Atmospheric structure detectors

TITLE: Develop and evaluate pressure gages and mass spectrometers

ORGANIZATION: Goddard Space Flight Center

COGNIZANT HEADQUARTERS OFFICE: Geophysics & Astronomy Programs

LEVEL OF EFFORT: \$100,000

TECHNICAL MONITOR: N. Spencer

DESCRIPTION: The development and evaluation of advanced designs of thermionic and cold cathode pressure gages and r.f. spectrometers which are planned for future satellite and probe applications. This includes development of metal-ceramic ion gages and low data rate r.f. spectrometer systems.

DISCIPLINE: Planetary Atmospheres

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Ion composition measurements

TITLE: Special techniques for particle detection

ORGANIZATION: Goddard Space Flight Center

COGNIZANT HEADQUARTERS OFFICE: Geophysics & Astronomy Programs

LEVEL OF EFFORT: \$156,000

TECHNICAL MONITOR: N. Spencer

DESCRIPTION: The objectives of this research are to extend the understanding of the physical processes involved in the performance of the RF spectrometer tube and to develop improved techniques in interpreting ion composition measurements. This includes theoretical and laboratory investigations intended to verify existing theories and to explore new areas.

DISCIPLINE: Planetary Atmospheres (prime)
Ionospheres & Radio Physics

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Meteorites and micrometeorites

TITLE: Dust particle detector development
and calibration

ORGANIZATION: Goddard Space Flight Center

COGNIZANT HEADQUARTERS
OFFICE: Geophysics & Astronomy Programs

LEVEL OF EFFORT: \$206,000

TECHNICAL MONITOR: W. M. Alexander

DESCRIPTION: Design and development of experiments
with subsequent development and
testing of sensors for measuring the
various parameters necessary to
describe the nature and origin of
interplanetary dust. These parameters
include flux vs. particle size,
spatial distribution, velocities,
densities and composition of the
particles. This research is in
direct support of flight experiments
for spacecraft such as OGO, Ranger,
Mariner and future comet probe
missions.

DISCIPLINE: Planetary Atmospheres

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Meteorites and micrometeorites

TITLE: Studies of extra-terrestrial material

ORGANIZATION: Goddard Space Flight Center

COGNIZANT HEADQUARTERS OFFICE: Geophysics & Astronomy Programs

LEVEL OF EFFORT: \$150,000

TECHNICAL MONITOR: J. A. O'Keefe

DESCRIPTION: Obtain a clearer insight of lunar and planetary surfaces and the composition of extra-terrestrial material by studying the mechanism by which grooves and pits are formed on tektites, the study of micrometeorites from Antarctic ice and the study of lunar impactites if such impactites can be recovered.

DISCIPLINE: Planetary Atmospheres (prime)
Planetology

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Cometary and space chemistry

TITLE: Low temperature crystal growth

ORGANIZATION: Goddard Space Flight Center

COGNIZANT HEADQUARTERS
OFFICE: Geophysics & Astronomy Programs

LEVEL OF EFFORT: \$139,000

TECHNICAL MONITOR: B. D. Donn

DESCRIPTION: Extend, by experimental and theoretical studies, the theory of crystal growth under astronomical conditions as related to interstellar and interplanetary grains. This will be followed by a laboratory study of the processes involved when condensed volatile matter is exposed to UV light and corpuscular radiation.

DISCIPLINE: Planetary Atmospheres (prime)
Planetology

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Ionospheric and radio physics

TITLE: Theoretical studies in ionospheric physics

ORGANIZATION: Goddard Space Flight Center

COGNIZANT HEADQUARTERS OFFICE: Geophysics & Astronomy Programs

LEVEL OF EFFORT: \$30,000

TECHNICAL MONITOR: W. N. Hess

DESCRIPTION: A task to perform theoretical studies on three body collisions.

DISCIPLINE: Ionospheres & Radio Physics (prime)
Planetary Atmospheres

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Ionospheres and Radio Physics

TITLE: Instrumentation and plasma studies

ORGANIZATION: Goddard Space Flight Center

COGNIZANT HEADQUARTERS
OFFICE: Geophysics & Astronomy Programs

LEVEL OF EFFORT: \$216,000

TECHNICAL MONITOR: R. Stone

DESCRIPTION: This program is directed toward an experimental study of the behavior of RF antennas and probes in a plasma and the development of ion composition and radiation detectors for studies of the lower ionosphere and the development of accurate and reliable instrumentation and technique for space-borne radio astronomy.

DISCIPLINE: Ionospheres & Radio Physics (prime)
Astronomy

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Ionospheres & Radio Physics

TITLE: Ionospheric research

ORGANIZATION: Goddard Space Flight Center

COGNIZANT HEADQUARTERS
OFFICE: Geophysics & Astronomy Programs

LEVEL OF EFFORT: \$35,000

TECHNICAL MONITOR: Thomas Beard

DESCRIPTION: This task established funds for the purchase of equipment and the training of personnel to operate three Brazilian stations to observe radio signals from the Polar Ionospheric Beacons.

DISCIPLINE: Ionospheres & Radio Physics

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Magnetodynamics in space

TITLE: World magnetic survey theoretical studies

ORGANIZATION: Goddard Space Flight Center

COGNIZANT HEADQUARTERS OFFICE: Geophysics & Astronomy Programs

LEVEL OF EFFORT: \$100,000

TECHNICAL MONITOR: J. P. Heppner/J. C. Cain

DESCRIPTION: Establish and test techniques for handling, analyzing, and presenting large quantities of geomagnetic field data.
Conduct special studies on time variations of the geomagnetic field utilizing surface station data.

DISCIPLINE: Particles & Fields

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Magnetodynamics in space

TITLE: Theoretical studies in magnetic fields

ORGANIZATION: Goddard Space Flight Center

COGNIZANT HEADQUARTERS
OFFICE: Geophysics & Astronomy Programs

LEVEL OF EFFORT: \$100,000

TECHNICAL MONITOR: W. N. Hess

DESCRIPTION: Continue to study the effects of magnetic fields on the evolutionary history of galaxies. Study problems of magnetohydrodynamics in space. Study processes occurring near null points in magnetic fields. Magnetohydrodynamic phenomena play a very important role in the processes that go on in space near the earth. Understanding the effects of field fluctuations, instabilities, particle loading and particle acceleration are necessary to understand the magnetosphere.

DISCIPLINE: Particles & Fields

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Magnetodynamics in space

TITLE: Advanced magnetometer development

ORGANIZATION: Goddard Space Flight Center

COGNIZANT HEADQUARTERS
OFFICE: Geophysics & Astronomy Programs

LEVEL OF EFFORT: \$150,000

TECHNICAL MONITOR: J. P. Heppner/N. F. Ness

DESCRIPTION: Development of advanced magnetometers of the alkali vapor atomic resonance type. Extended spacecraft missions such as solar and planetary probes demand the development of magnetometers that operate over a very wide dynamic range.

DISCIPLINE: Particles & Fields

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Energetic particles

TITLE: Development of particle detectors

ORGANIZATION: Goddard Space Flight Center

COGNIZANT HEADQUARTERS
OFFICE: Geophysics & Astronomy Programs

LEVEL OF EFFORT: \$405,000

TECHNICAL MONITOR: Frank B. McDonald

DESCRIPTION: To develop and test new particle detectors and data processing equipment. Detectors in current use need improvements in a number of characteristics including stability, temperature range of operability, the signal-to-noise ratio, and dynamic range and new detectors are required which have improved energy resolution, charge resolution, etc.

DISCIPLINE: Particles & Fields

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Energetic particles

TITLE: Theoretical studies in cosmic rays

ORGANIZATION: Goddard Space Flight Center

COGNIZANT HEADQUARTERS OFFICE: Geophysics & Astronomy Programs

LEVEL OF EFFORT: Two in-house man-years effort

TECHNICAL MONITOR: W. N. Hess

DESCRIPTION: This study will involve the computation of trajectories of cosmic ray protons in the earth's magnetic field. The earth's field will be simulated in two different ways: (a) simple earth centered dipole, (b) by making use of the more precise harmonic expansion of the earth's field due to the work of Finch and Leaton. A further improvement will be made by considering a few simple models of the distortion of the earth's field due to the solar wind. Develop a theory of the motion of cosmic radiation in interplanetary space consistent with their observed time variations. Attempt to find the cause of the following observed effects: (a) anisotropy of cosmic radiation in space, (b) decreases connected with magnetic storms, (c) variations with the same period as the solar rotation (27 days) (d) variations over solar cycle. All these variations depend on the sun and presumably bear on the electromagnetic fields in interplanetary space.

DISCIPLINE: Particles & Fields

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Radio & Radar Astronomy

TITLE: Radio Astronomy

ORGANIZATION: Jet Propulsion Laboratory

COGNIZANT HEADQUARTERS
OFFICE: Lunar & Planetary Programs

LEVEL OF EFFORT: \$131,000

TECHNICAL MONITOR: Frank B. Gray

DESCRIPTION: Investigate the physical processes occurring in planetary atmospheres by measurement of intensity and line widths of millimeter wave emission from and thru these atmospheres. Determine planet surface characteristics by means of emissivity mapping techniques.

Venus will be observed in the 8.6 mm region with the existing 10' dish and sweep frequency radiometer. In addition the moon will be observed and used as a calibration body. Observations will be extended to the 1.25 mm region by use of a He cooled Ge bolometer.

DISCIPLINE: Astronomy (prime)
Planetary Atmospheres

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Astronomy

TITLE: Astronomical Observations

ORGANIZATION: Jet Propulsion Laboratory

COGNIZANT HEADQUARTERS
OFFICE: Lunar & Planetary Programs

LEVEL OF EFFORT: \$322,000

TECHNICAL MONITOR: Frank B. Gray

DESCRIPTION: Using Coude focus spectrometers, extend our knowledge of the moon and the planets through ground-based observation and measurements. Determine the compositions, thermal structures and velocity fields in planetary atmospheres, and acquire knowledge on the characteristics of the lunar surface.

DISCIPLINE: Astronomy (prime)
Planetary Atmospheres
Planetology

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Space science instruments

TITLE: Infrared instrumentation

ORGANIZATION: Jet Propulsion Laboratory

COGNIZANT HEADQUARTERS
OFFICE: Lunar & Planetary Programs

LEVEL OF EFFORT: \$105,000

TECHNICAL MONITOR: D. D. La Porte

DESCRIPTION: Develop an interferometer spectrometer of rapid scan capability (20 sec.) which is suitable for Mars '66-'69 mission. The advantages offered by the interferometer over a dispersion instrument are: 1) more thru put for same weight and power; 2) Ability to take lower intensity spectra in the 1.5 to 6 micron region. Complete the assembly and testing of the IR radiometer. Study detector cooling systems suitable for spacecraft use.

DISCIPLINE: Planetary Atmospheres (prime)
Planetology

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Space science instruments

TITLE: Gas chromatograph

ORGANIZATION: Jet Propulsion Laboratory

COGNIZANT HEADQUARTERS
OFFICE: Lunar & Planetary Programs

LEVEL OF EFFORT: \$72,000

TECHNICAL MONITOR: C. Josias

DESCRIPTION: Develop gas chromatograph technology in the direction of low-volume, lightweight instrumentation suitable for Voyager planetary entry capsules. Investigations will be directed toward both atmospheric and organic systems.
Perform in-house development of a system having wide dynamic range, fast response, and long-term stability.
Continue development of electrometer systems.
Continue work on automatic baseline stabilization.
Investigate ionization sources for detectors and suitable mounting arrangements.
Develop peak reading and peak integrating electronics for automatic readout of retention times and peak areas.

DISCIPLINE: Planetary Atmospheres (prime)
Planetology (prime)

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Space science instruments

TITLE: UV Spectrometer

ORGANIZATION: Jet Propulsion Laboratory

COGNIZANT HEADQUARTERS
OFFICE: Lunar & Planetary Programs

LEVEL OF EFFORT: \$103,000

TECHNICAL MONITOR: Robert J. Mackin, Jr.

DESCRIPTION: Conduct spectroscopic investigation of the ultraviolet spectrum of atmospheric gases with a variety of instruments and techniques. The intensity distributions in spectra of planetary atmospheres provide information on the composition and physical processes occurring there. This project will provide a vital link between the scientific laboratory and theoretical backup necessary for detailed quantitative understanding of future ultraviolet experiments on planetary atmospheres and the actual planning, design and performance of these experiments.

DISCIPLINE: Planetary Atmospheres

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Planetary Atmospheres

TITLE: Planetary Atmospheres

ORGANIZATION: Jet Propulsion Laboratory

COGNIZANT HEADQUARTERS
OFFICE: Lunar & Planetary Programs

LEVEL OF EFFORT: \$416,000

TECHNICAL MONITOR: Frank B. Gray

DESCRIPTION: Quantitative spectra of long paths of CO₂, N₂, CH₄, NH₃, will be obtained in high and low resolution and at varying pressure and temperature using a 20', high temperature, high pressure White Cell. Also, there will be the calculation of model atmospheres, and the determination of their heat, balance and hydrodynamics. The results will be used, together with existing astrophysical data and data to be obtained thru a planned program of extended observations including spectra obtained with an interferometric spectrometer, in planning future experiments. Design of a 150' White Cell will be initiated.

DISCIPLINE: Planetary Atmospheres

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Geochemistry

TITLE: Ion source and surface studies

ORGANIZATION: Jet Propulsion Laboratory

COGNIZANT HEADQUARTERS
OFFICE: Lunar & Planetary Programs

LEVEL OF EFFORT: \$65,000

TECHNICAL MONITOR: Frank B. Gray

DESCRIPTION: Develop a flight mass spectrometer that will be capable of measuring the composition at the extremely low pressures found in the lunar atmosphere, solar wind, deep space, and possibly comet tails.

DISCIPLINE: Planetary Atmospheres (prime)
Particles & Fields
Planetology

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Space science instruments

TITLE: Mass spectrometer for planetary atmospheres

ORGANIZATION: Jet Propulsion Laboratory

COGNIZANT HEADQUARTERS OFFICE: Lunar & Planetary Programs

LEVEL OF EFFORT: \$85,000

TECHNICAL MONITOR: Frank B. Gray

DESCRIPTION: Develop a flight package mass spectrometer for planetary atmosphere analysis. The target weight and power maximums are to be five pounds and five watts.

DISCIPLINE: Planetary Atmospheres

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Planetary Atmospheres

TITLE: Simple composition methods

ORGANIZATION: Jet Propulsion Laboratory

COGNIZANT HEADQUARTERS
OFFICE: Lunar & Planetary Programs

LEVEL OF EFFORT: \$88,000

TECHNICAL MONITOR: Frank B. Gray

DESCRIPTION: Build and fly instruments to measure N_2 , CO_2 , A, and O_3 in the atmospheres of Mars and Venus. Test "laboratory models" already developed under conditions of simulated descent through planetary atmospheres. This would include measurement of sensitivity, accuracy, and time constants under the dynamic conditions of changing pressure and temperature. The laboratory test equipment is already available. To determine the design parameters for nitrogen analysis by the Rutherford reaction by in-house measurements of proton energy spectra as a function of angle and energy of alpha source.

DISCIPLINE: Planetary Atmospheres

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Geochemistry

TITLE: High temperature gas absorption tube

ORGANIZATION: Jet Propulsion Laboratory

COGNIZANT HEADQUARTERS
OFFICE: Lunar & Planetary Programs

LEVEL OF EFFORT: \$55,000

TECHNICAL MONITOR: C. Thiele

DESCRIPTION: Perform design studies and initiate the engineering design of a multi-pass absorption tube which is to be used in the study of absorption phenomena in planetary atmospheres. Various gases which are expected to be found in the atmospheres of planets must be confined at high pressures and temperatures under conditions of extreme purity

DISCIPLINE: Planetary Atmospheres

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Space science instruments

TITLE: Gas chromatograph component development

ORGANIZATION: Jet Propulsion Laboratory

COGNIZANT HEADQUARTERS OFFICE: Lunar & Planetary Programs

LEVEL OF EFFORT: \$114,000

TECHNICAL MONITOR: C. Thiele

DESCRIPTION: In order to advance the state-of-the-art in this field columns will be studied to improve their separation characteristics by varying materials, temperature, and number of columns used. Detectors will be evaluated, miniaturized, and "staged" to provide specificity. Sampling values will be miniaturized without sacrificing purity of sample. Finally, new systems concepts, such as moving ovens, etc. will be investigated.

DISCIPLINE: Planetary Atmospheres (prime)
Planetology (prime)

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Space sciences instruments

TITLE: I.R. Spectrometer testing & evaluation

ORGANIZATION: Jet Propulsion Laboratory

COGNIZANT HEADQUARTERS
OFFICE: Lunar & Planetary Programs

LEVEL OF EFFORT: \$169,000

TECHNICAL MONITOR: C. Thiele

DESCRIPTION: Design, construct, test and evaluate a scientific breadboard model of a fixed grating, multiple detector infrared spectrometer. Demonstrate feasibility of using this instrument for: making temperature soundings in atmospheres and determining the existence of biology on planet surfaces from emission spectra.

DISCIPLINE: Planetary Atmospheres (prime)
Planetology (prime)
Bioscience (prime)

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Space science instruments

TITLE: UV Spectrometer calibration

ORGANIZATION: Jet Propulsion Laboratory

COGNIZANT HEADQUARTERS
OFFICE: Lunar & Planetary Programs

LEVEL OF EFFORT: \$96,000

TECHNICAL MONITOR: C. Thiele

DESCRIPTION: Develop the necessary techniques to calibrate spectrometric flight instruments for use in the vacuum ultraviolet portion of the spectrum. The development of ultraviolet sources, calibrated detectors, and an improved vacuum chamber are initial tasks.

DISCIPLINE: Planetary Atmospheres (prime)
Solar Physics
Astronomy

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Aeronomy

TITLE: Nightglow measurement

ORGANIZATION: Jet Propulsion Laboratory

COGNIZANT HEADQUARTERS
OFFICE: Geophysics & Astronomy Programs

LEVEL OF EFFORT: \$60,000

TECHNICAL MONITOR: C. Thiele

DESCRIPTION: In measuring the nightglow in the earth's atmosphere, extremely small quantities of radiated energy must be measured, stored, and displayed. This research includes the investigation of sensors, circuits appropriate to blue sensors and data display techniques.

DISCIPLINE: Planetary Atmospheres

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Planetary Atmospheres

TITLE: Upper atmosphere atomic physics

ORGANIZATION: Jet Propulsion Laboratory

COGNIZANT HEADQUARTERS
OFFICE: Geophysics & Astronomy Programs

LEVEL OF EFFORT: \$178,000

TECHNICAL MONITOR: R. J. Mackin, Jr.

DESCRIPTION: The phenomena that are being studied in the laboratory include those important in the night airglow, the twilight glow, the dayglow, the aurora, and upper atmosphere atomic and ionic reactions. The experimental techniques that are used are: (1) the measurement of atomic densities and reactions with electron paramagnetic resonance spectroscopy; (2) the study of night airglow emissions with high-speed optical spectrographs in the near ultraviolet, the visible, and the infrared; and, (3) the examination of dayglow and auroral emissions with vacuum ultraviolet spectrometers. Theoretical calculations are performed with the aim of predicting spectral features of the atmosphere using cross-sections and reaction rates determined in laboratory experiments.

DISCIPLINE: Planetary Atmospheres (prime)
Ionospheres & Radio Physics

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Space science instrumentation

TITLE: Advanced magnetics instruments

ORGANIZATION: Jet Propulsion Laboratory

COGNIZANT HEADQUARTERS
OFFICE: Lunar & Planetary Programs

LEVEL OF EFFORT: \$57,000

TECHNICAL MONITOR: J. Lawrence

DESCRIPTION: Design and evaluate gas sensors and electronics in terms of the space-craft environment to provide a highly reliable absolute magnetometer which would have the wide dynamic range common to the fluxgate type, but would have the high sensitivity and null stability afforded by the gas system.

DISCIPLINE: Particles & Fields

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Space science instrumentation

TITLE: Advanced plasma instruments

ORGANIZATION: Jet Propulsion Laboratory

COGNIZANT HEADQUARTERS
OFFICE: Lunar & Planetary Programs

LEVEL OF EFFORT: \$71,000

TECHNICAL MONITOR: J. Lawrence

DESCRIPTION: Broaden existing capability in solar plasma instrumentation by development of electronics which will allow a greater and more accurate coverage of the spectral distribution. Examine systems which will enable charged particle identification and provide ability to measure very low flux density plasma.

DISCIPLINE: Particles & Fields

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Particles & Fields

TITLE: Radiation experiments

ORGANIZATION: Jet Propulsion Laboratory

COGNIZANT HEADQUARTERS
OFFICE: Lunar & Planetary Programs

LEVEL OF EFFORT: \$108,000

TECHNICAL MONITOR: Robert J. Mackin, Jr.

DESCRIPTION: Measure the directionality of
 protons and alphas in space as a
 function of energy. Such data will
 be of particular interest for solar
 flare particles in that it will give
 information on the large scale
 magnetic fields between the probe
 and the sun which control the tra-
 jectories of the particles.

DISCIPLINE: Particles & Fields

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Space science instruments

TITLE: Magnetics

ORGANIZATION: Jet Propulsion Laboratory

COGNIZANT HEADQUARTERS
OFFICE: Lunar & Planetary Programs

LEVEL OF EFFORT: \$98,000

TECHNICAL MONITOR: C. Thiele

DESCRIPTION: Design a facility which permits
accurate calibration of magnetometers
without interference from external
field fluctuations.
Research on new techniques of
field detection to cover a wider
dynamic range as well as lower field
strengths.

DISCIPLINE: Particles & Fields

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Magnetodynamics in space

TITLE: Magnetic phenomena

ORGANIZATION: Jet Propulsion Laboratory

COGNIZANT HEADQUARTERS
OFFICE: Geophysics & Astronomy Programs

LEVEL OF EFFORT: \$48,000

TECHNICAL MONITOR: Robert J. Mackin, Jr.

DESCRIPTION: Provide continuing research in geomagnetism to support space measurements (EGO, POGO, Mariner, Ranger). Develop ground-station equipment and techniques with a view to adapting them to flight equipment. Produce a nearly field-free region, shielded from magnetic variations, for the evaluation, calibration and testing of flight magnetometers.

DISCIPLINE: Particles & Fields

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Space science instruments

TITLE: RF Thermal mapping radiometer

ORGANIZATION: Jet Propulsion Laboratory

COGNIZANT HEADQUARTERS
OFFICE: Lunar & Planetary Programs

LEVEL OF EFFORT: \$59,000

TECHNICAL MONITOR: F. Barath

DESCRIPTION: Develop an instrument capable of space flight that can provide a high resolution thermal photograph of a planet's surface from a fly-by or orbiting spacecraft of the Voyager class.

DISCIPLINE: Planetology

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Space science instruments

TITLE: Radio frequency emission spectra

ORGANIZATION: Jet Propulsion Laboratory

COGNIZANT HEADQUARTERS
OFFICE: Lunar & Planetary Programs

LEVEL OF EFFORT: \$60,000

TECHNICAL MONITOR: F. Barath

DESCRIPTION: Measure the broadband RF emission characteristics of natural terrain materials in order to relate their radiometric properties to their composition and physical state.

DISCIPLINE: Planetology

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Space science instruments

TITLE: Gamma ray

ORGANIZATION: Jet Propulsion Laboratory

COGNIZANT HEADQUARTERS
OFFICE: Lunar & Planetary Programs

LEVEL OF EFFORT: \$62,000

TECHNICAL MONITOR: D. Margetts

DESCRIPTION: Test and evaluate the 128
channel Loral pulse height
analyzer.
Develop a cabling system and
power supply for the improved
C.R. detector.
Develop a new circuit for
pulse shape discrimination of
neutrons and gamma-rays in
scintillation detectors.
Continue limited participation
in neutron activation investi-
gation.

DISCIPLINE: Planetology

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Geology

TITLE: Sample handling

ORGANIZATION: Jet Propulsion Laboratory

COGNIZANT HEADQUARTERS
OFFICE: Lunar & Planetary Programs

LEVEL OF EFFORT: \$92,000

TECHNICAL MONITOR: C. Thiele

DESCRIPTION: Investigate techniques used on soft landing spacecraft in the acquisition and distribution of surface samples. Study effects of collection, distribution, and preparation techniques on the samples. Samples thus obtained will be compared to standard samples on laboratory instruments. Parameters to be investigated include particle size distribution, preferential sorting and orientation of crystals, for example, overheating of samples, contamination from the sampling system, area coverage of the sample collector, etc.

DISCIPLINE: Planetology

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Particles & Fields

TITLE: Neutron albedo experiment

ORGANIZATION: Jet Propulsion Laboratory

COGNIZANT HEADQUARTERS
OFFICE: Lunar & Planetary Programs

LEVEL OF EFFORT: \$38,000

TECHNICAL MONITOR: Robert J. Mackin, Jr.

DESCRIPTION: The long-range objective is an experimental determination of the lunar neutron albedo, which, while presumably greater than that of the earth is also subject to the same sort of time-variations. Measurements conducted near the earth will enable one to estimate the importance of these variations in the lunar albedo, which is of interest because of its hydrogen sensitivity and because of the radiation hazard it represents to manned lunar exploration.

DISCIPLINE: Planetology

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Geology

TITLE: Planetology studies

ORGANIZATION: Jet Propulsion Laboratory

COGNIZANT HEADQUARTERS
OFFICE: Lunar & Planetary Programs

LEVEL OF EFFORT: \$14,000

TECHNICAL MONITOR: Frank B. Gray

DESCRIPTION: Define problems of Mars for investigation by spacecraft. Define geological problems of Venus. Compare Mars with the other terrestrial planets and with stone meteorites with regard to compositional differences and their importance to models of the origin of the solar system and of the thermal histories of the planets. Evaluate the expected changes in rock differentiation trends with compositional changes (including the well-known iron-abundance change) from planet to planet.

DISCIPLINE: Planetology

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Geology

TITLE: X-ray mineralogy

ORGANIZATION: Jet Propulsion Laboratory

COGNIZANT HEADQUARTERS
OFFICE: Lunar & Planetary Programs

LEVEL OF EFFORT: \$12,000

TECHNICAL MONITOR: Frank B. Gray

DESCRIPTION: Conduct experiments and studies on X-ray diffraction analysis to prove its capabilities as an important and rapid technique for determining the SiO₂ content of glasses, rock, and minerals.

DISCIPLINE: Planetology

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Geology

TITLE: Thermal problems

ORGANIZATION: Jet Propulsion Laboratory

COGNIZANT HEADQUARTERS
OFFICE: Lunar & Planetary Programs

LEVEL OF EFFORT: \$24,000

TECHNICAL MONITOR: Frank B. Gray

DESCRIPTION: Make calculations on the thermal history of the earth, moon, and planets, and develop methods for lunar and planetary heat flow measurements using a heat flux meter.

DISCIPLINE: Planetology

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Geology

TITLE: Lunar studies

ORGANIZATION: Jet Propulsion Laboratory

COGNIZANT HEADQUARTERS
OFFICE: Lunar & Planetary Programs

LEVEL OF EFFORT: \$54,000

TECHNICAL MONITOR: Frank B. Gray

DESCRIPTION: Define the problems of the lunar surface and determine optimum methods for solutions of these problems. Make photogeological studies of lunar photographs taken in the UV and near IR and observational and theoretical studies of lunar surface processes. Conduct studies of spectral emittance of silicates and their powders.

DISCIPLINE: Planetology

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Geology

TITLE: Petrological studies

ORGANIZATION: Jet Propulsion Laboratory

COGNIZANT HEADQUARTERS
OFFICE: Lunar & Planetary Programs

LEVEL OF EFFORT: \$76,000

TECHNICAL MONITOR: Frank B. Gray

DESCRIPTION: These petrologic studies are designed to further our understanding of the development of silicate systems under various environments and to relate these results with possible planetary models. Another objective is to suggest methods of petrologic analysis which may be applicable to spacecraft operations.

DISCIPLINE: Planetology

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Geochemistry

TITLE: Neutron activation

ORGANIZATION: Jet Propulsion Laboratory

COGNIZANT HEADQUARTERS
OFFICE: Lunar & Planetary Programs

LEVEL OF EFFORT: \$62,000

TECHNICAL MONITOR: Frank B. Gray

DESCRIPTION: Develop a neutron activation analysis
system for the determination of
planetary and lunar surface composi-
tion.

DISCIPLINE: Planetology

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Space science instruments

TITLE: Advanced X-ray instrumentation

ORGANIZATION: Jet Propulsion Laboratory

COGNIZANT HEADQUARTERS
OFFICE: Lunar & Planetary Programs

LEVEL OF EFFORT: \$27,000

TECHNICAL MONITOR: Frank B. Gray

DESCRIPTION: Engage in feasibility and design studies of dispersive and non-dispersive scanning and fixed, electron and fluorescence excited X-ray systems with a view to developing new approaches to instrumentation designed to perform remote elemental and possible mineralogical analysis and thus produce a unit worthy of inclusion in a planetary or lunar landing payload.

DISCIPLINE: Planetology

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Space science instruments

TITLE: Gamma ray spectrometer

ORGANIZATION: Jet Propulsion Laboratory

COGNIZANT HEADQUARTERS
OFFICE: Lunar & Planetary Programs

LEVEL OF EFFORT: \$28,000

TECHNICAL MONITOR: Frank B. Gray

DESCRIPTION: Fabrication and flight of a gamma ray spectrometer to detect natural and induced lunar radioactivities to throw light on the composition, heat balance, and history of the moon. Such a measurement would best be accomplished on a vehicle orbiting the moon.

DISCIPLINE: Planetology

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Exobiology

TITLE: Desert microflora

ORGANIZATION: Jet Propulsion Laboratory

COGNIZANT HEADQUARTERS
OFFICE: Bioscience Programs

LEVEL OF EFFORT: \$174,000

TECHNICAL MONITOR: H. Ford

DESCRIPTION: Determine the response of controlled soil ecosystems consisting of defined soils, particularly with reference to response and activity of indigenous microorganisms to moisture.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Exobiology

TITLE: Metabolism and growth

ORGANIZATION: Jet Propulsion Laboratory

COGNIZANT HEADQUARTERS
OFFICE: Bioscience Programs

LEVEL OF EFFORT: \$179,000

TECHNICAL MONITOR: H. Ford

DESCRIPTION: Study refinements of fluorometric analysis of nucleic acids, proteins, and pigments of soil organisms in soils. Develop fluorometric methods for carbohydrates, polycarboxylic acids and other compounds involved in photosynthesis and respiration. Develop fluorometric methods for enzymatic reactions occurring in photosynthesis and respiration of soil microorganisms in soil suspension.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Exobiology

TITLE: Space biology instrumentation

ORGANIZATION: Jet Propulsion Laboratory

COGNIZANT HEADQUARTERS
OFFICE: Bioscience Programs

LEVEL OF EFFORT: \$79,000

TECHNICAL MONITOR: J. Stuart

DESCRIPTION: Investigate the engineering problems of lightweight sample collection systems for planetary capsule missions; and of measuring ph, conductivity, optical illumination filtering and detection, and other life detection techniques. Provide engineering support in the formulation of exobiological experiments for Voyager.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Exobiology

TITLE: Mars biological microscope

ORGANIZATION: Jet Propulsion Laboratory

COGNIZANT HEADQUARTERS
OFFICE: Bioscience Programs

LEVEL OF EFFORT: \$143,000

TECHNICAL MONITOR: H. Ford

DESCRIPTION: Develop a biological microscope to be used for the detection or identification of extraterrestrial life. There are many problems to be solved to enable a microscope to be used for identifying unknown organisms. These are in the fields of photoscience, sample enhancement, and physical chemical methods of identifying objects.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Exobiology

TITLE: Multivator

ORGANIZATION: Jet Propulsion Laboratory

COGNIZANT HEADQUARTERS
OFFICE: Bioscience Programs

LEVEL OF EFFORT: \$6,000

TECHNICAL MONITOR: H. Ford

DESCRIPTION: Maintain cognizance of development
of Lederberg's Multivator System.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Exobiology

TITLE: Desert microflora

ORGANIZATION: Jet Propulsion Laboratory

COGNIZANT HEADQUARTERS
OFFICE: Bioscience Programs

LEVEL OF EFFORT: \$41,000

TECHNICAL MONITOR: C. Thiele

DESCRIPTION: Advance the state-of-the-art in
soil properties instrumentation.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Exobiology

TITLE: Carbonaceous chondrites studies

ORGANIZATION: Jet Propulsion Laboratory

COGNIZANT HEADQUARTERS
OFFICE: Bioscience Programs

LEVEL OF EFFORT: \$55,000

TECHNICAL MONITOR: H. Ford

DESCRIPTION: Study the composition and properties of the compounds which are in the only extraterrestrial organic matter now available. Characterization of the organic moiety in these meteorites in the realm of their synthesis within the solar system and in comparison with their terrestrial counterparts.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Sterilization

TITLE: Physical and/or chemical sterility indicators

ORGANIZATION: Jet Propulsion Laboratory

COGNIZANT HEADQUARTERS OFFICE: Bioscience Programs

LEVEL OF EFFORT: \$40,000

TECHNICAL MONITOR: K. Coon

DESCRIPTION: Develop physical and/or chemical test methods which will indicate that proper sterilization conditions have been attained in the environment being treated. Methods would be directed primarily towards dry heat and ethylene oxide mixture sterilization procedures.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Sterilization

TITLE: Microbiological filters

ORGANIZATION: Jet Propulsion Laboratory

COGNIZANT HEADQUARTERS
OFFICE: Bioscience Programs

LEVEL OF EFFORT: \$50,000

TECHNICAL MONITOR: K. Coon

DESCRIPTION: Evaluate and select biological filters or filter materials that are capable of sterilizing fluids and gases which will be used on planetary spacecraft. Test methods will be both biological and physical. Select or develop a physical test method which will be reliable for indicating microbial retentive efficiency of filters.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Sterilization

TITLE: Microbiological analysis techniques
for spacecraft sterilization

ORGANIZATION: Jet Propulsion Laboratory

COGNIZANT HEADQUARTERS
OFFICE: Bioscience Programs

LEVEL OF EFFORT: \$10,000

TECHNICAL MONITOR: W. Shipley

DESCRIPTION: Develop reliable analytical methods
for the determination of viable
microorganisms within materials and
on surfaces of spacecraft components
which have been exposed to a
sterilization procedure.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Exobiology

TITLE: Sample acquisition and handling

ORGANIZATION: Jet Propulsion Laboratory

COGNIZANT HEADQUARTERS
OFFICE: Bioscience Programs

LEVEL OF EFFORT: \$21,000

TECHNICAL MONITOR: H. Ford

DESCRIPTION: Study unit operations suitable for automatically obtaining a sample for examination and analysis. Determine the effect of the sampling system on the sample composition and physical properties. Of importance will be effects such as fractionation or thermal decomposition.

DISCIPLINE: Bioscience

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Astronomy

TITLE: Study and extension of cosmological theory and correlation with observation

ORGANIZATION: Langley Research Center

COGNIZANT HEADQUARTERS OFFICE: Geophysics & Astronomy Programs

LEVEL OF EFFORT: \$5,000

TECHNICAL MONITOR: J. D. Bird

DESCRIPTION: Study and extend current cosmological theory and correlate the theoretical and experimental results in order to identify the correct model universe. In addition, studies will be made to determine which astronomical and astrophysical observations, yielding the most significant cosmological data, that are worthy of being done in a satellite and provide methods of data analysis.

DISCIPLINE: Astronomy

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Chemistry of the upper atmosphere

TITLE: Study of the kinetics and rates of physical chemical reactions of interest in the upper atmosphere

ORGANIZATION: Marshall Space Flight Center

COGNIZANT HEADQUARTERS OFFICE: Geophysics & Astronomy Programs

LEVEL OF EFFORT: \$125,000

TECHNICAL MONITOR: S. G. Frary

DESCRIPTION: Study of physical chemical reactions of interest in the upper atmosphere with special emphasis on the behavior of water under intense solar radiation. A crossed molecular beam technique in an ultra-high vacuum system will be employed to study the dissociation of water under upper atmosphere environmental conditions and the reactions of it and its dissociation products with the constituents of the atmosphere.

DISCIPLINE: Planetary Atmospheres (prime)
Ionospheres & Radio Physics

SUPPORTING RESEARCH AT NASA CENTERS

AREA OF INVESTIGATION: Ionospheres & Radio Physics

TITLE: Measurement of ionospheric electron content

ORGANIZATION: Marshall Space Flight Center

COGNIZANT HEADQUARTERS OFFICE: Geophysics & Astronomy Programs

LEVEL OF EFFORT: \$70,000

TECHNICAL MONITOR: E. A. Mechtly

DESCRIPTION: A program of ionospheric propagation studies carried out at the Marshall Space Flight Center supplemented by data reduction support from the Alabama Agricultural and Mechanical College, Huntsville. Current plans are to receive signals from the Polar Ionosphere Beacons and subsequent earth satellites having appropriate transmitters.

DISCIPLINE: Ionospheres & Radio Physics